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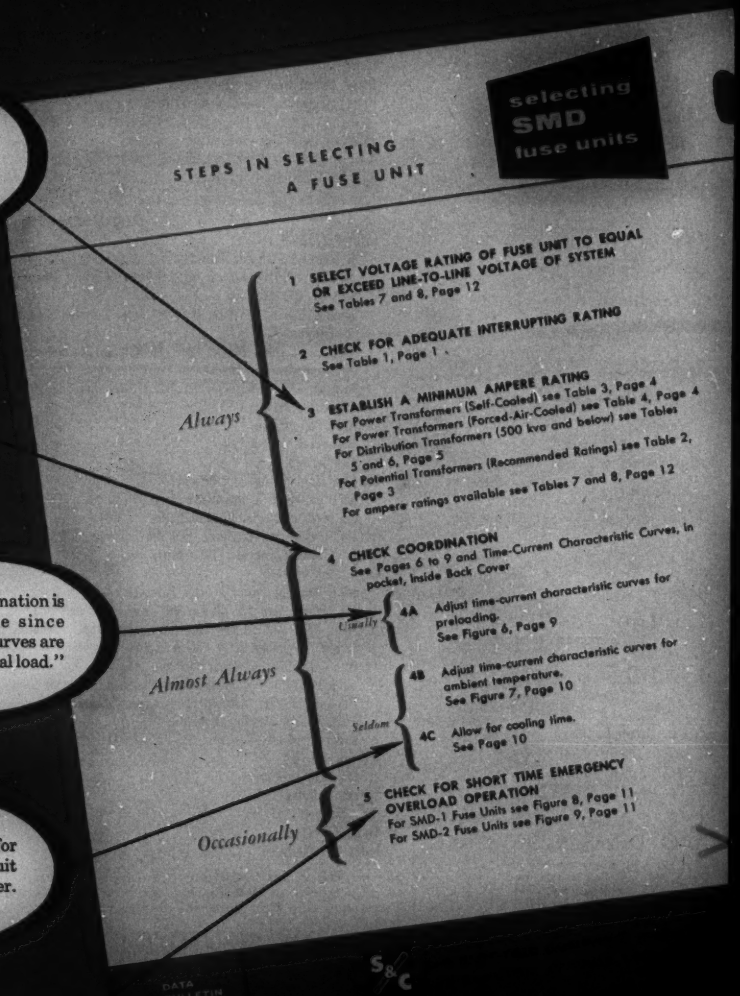
selecting SMD fuse units
STEPS IN SELECTING A FUSE UNIT
Always
1 SELECT VOLTAGE RATING OF FUSE UNIT TO EQUAL OR EXCEED LINE-TO-LINE VOLTAGE OF SYSTEM
See Tables 7 and 8, Page 12
2 CHECK FOR ADEQUATE INTERRUPTING RATING
See Table 1, Page 1
3 ESTABLISH A MINIMUM AMPERE RATING
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Almost Always
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Usually
4A Adjust time-current characteristic curves for preloading.
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Effective Appraisal of Engineers

J. A. NEWMAN

An engineer's on-the-job performance often is fallaciously taken as evidence of fitness for a position with different or greater responsibilities and duties. Programs of appraisal result in more effective utilization of engineering manpower potentials and the reduction of costly personnel turnover.

TO BEGIN by reiterating the obvious, there exists today a serious shortage of engineers. This has been estimated at between 100,000 and 200,000. An accruing annual deficit swells this total. With a population age distribution unfavorable to an increasing supply and with demand enhanced by a steadily expanding economy, the shortage problem can be expected to become considerably more acute before improving.

Some industries are more affected than others. A 1954 National Science Foundation survey of 11,000 companies disclosed the heaviest incidence of shortage to exist in the aircraft, electronic, and heavy-machinery industries. In the same study, it was pointed out that the electrical engineer—as contrasted to those in other engineering fields—was in shortest supply. Hence, the engineer, but especially the electrical engineer, is an extremely scarce commodity.

What are the implications of this situation? First, salaries are going up. This has been particularly true of starting salaries for inexperienced graduate engineers, which now fall within a range of $450 to $480 a month. At the same time, salaries for upper-level engineers have not been increased at a similar rate. In other words, the historical margin between salaries of beginning engineers and those of experienced engineers has been narrowed. Thus, commensurate rewards for positions of greater responsibility are harder to give. Inequities have arisen, and instances are common where the beginning engineer is being paid more than one who came into the company a year or two earlier. In many other situations, in response to market conditions, the total engineering salary structure has been pushed out of line with that prevailing for other company areas. The shortage in these instances has distorted the entire compensation structure.

Other problems have been engendered. Recruitment costs have risen to new highs. One company reports that costs run, on the average, half of the first year's salary. Another estimates spending $2,800 in procurement costs for each new engineer added. Still another problem is turnover. More and more job opportunities plus a too-slow movement of engineers upward has produced excessive turnover, at first concentrated largely at the lower levels but now also becoming serious at the higher levels. It is estimated that engineering requirements are now 50% more than before World War II and turnover almost twice as high. Thus, the shortage problem tends to multiply itself.

What is the answer to this acute problem? The obvious conclusion is to provide more engineers, but this calls for a long-term build-up in our engineering institutions, in teaching staffs, and in facilities and equipment. Most certainly it will not provide any real relief for the next three to five years. An alternative course suggested is to make more effective use of the engineers we have today. Much has been written on how to utilize today's engineering talent to the maximum degree. One of the most interesting articles appears in the October 20, 1956, issue of *Business Week*, and is entitled "Getting More Mileage out of the Engineer." This is a subject separate and apart from this article, but is significant because the effective use of engineers begins with effective appraisal.

THE FUNCTION OF APPRAISAL

IT IS OBVIOUS that one must know the strengths and weaknesses of engineering personnel before being able to capitalize on abilities or to point development toward a specific objective. It is also recognized that under today's management supply deficits, supervisory spots must be filled largely from within. This can be done intelligently only if we know the best existing talent among the engineering group. Thus, a constant choice of personnel is being made and a continuing appraisal function is at work to enhance engineering effectiveness.

But the role of appraisal does not terminate here. It is necessary for effective placement, transfer, or special assignments. It becomes the only realistic basis for both immediate and long-range manpower planning. The appraisal of existing personnel can become the basis of realistic employment standards, built of the characteristics which make up the most effective engineers now on hand. So appraisal has multiple uses, any of which could be termed significant to company success.

AN UNAVOIDABLE TASK

AT THIS POINT—knowing the more tangible dimensions of appraisal—we can cast aside any remaining naivete. The practical fact is that one cannot avoid the appraisal

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task. It is inherent in business activity. In any circumstance, people must be chosen for this or that task—for promotion, for compensation changes, or for numerous other reasons. This is the role of appraisal. Now this can be done on a "fly by the seat of the pants" basis or, alternatively, by following a planned, organized approach. The rugged individualists of the former philosophy are rapidly fading, and enlightened management is becoming strongly inclined toward an organized approach for improved results. But how can one build such a program?

WHO IS TO BE APPRAISED?

THE APPRAISAL OF ENGINEERS may apply to several different classes of personnel. Essentially, the appraisal must be made of men in two categories. The first includes those men who are new to a company. They may be either new recruits as young engineers out of college, or they may be more experienced men who are seeking middle management or top management positions. The second major category includes the men within the company. The purpose here is to identify men for promotion, to analyze training needs, or to determine how to compensate the present staff. When we appraise either of these broad categories, we must keep in mind the hoped-for end result of our appraisal efforts. What are we appraising the man against? What standards or gauges constitute the unit of measurement?

YARDSTICKS FOR APPRAISAL

THE ENGINEER'S PERFORMANCE on his current job is more often than not taken as primary evidence of his fitness to assume other jobs of differing responsibilities and duties. This is a basic fallacy at work in all company areas, but it is particularly dangerous in the engineering area—especially so if the movement is from the duty of a professional engineer to that of a management person. This latter transition is most difficult and more tortuous in engineering than in other areas.

The first yardstick for appraisal, therefore, should be a look at the future employment of the individual rather than the sole measure of present or past job performance. Appraisal is best when tied to foresight rather than hindsight. This means we should derive the man requirements or specifications for the job for which we are considering the engineer. Then he should be specifically measured against those job requirements. Only in this fashion can his qualifications for candidacy be fully evaluated and his weaknesses identified so that any necessary corrective measures can be taken.

But another step should also be pursued. Appraisal, from a management point of view, should provide the basis for long-range manpower planning. Thus, the engineer should be looked at in terms of how far up into the engineering or management structure he could ultimately be expected to climb. Now, admittedly, this can only be a rough estimate, but repeated appraisals will converge on the right answer to his long-range potential. In this way, management will have a sounder basis—particularly as multiple appraisals are accumulated—for planning its usage and replacement of engineers. This is a critical phase of planning often overlooked, and is a basic appraisal requirement.

Two major appraisal areas are particularly pertinent to gauging long-range potential. These are human relations and analytical ability. Research indicates that most engineers who fail in higher positions with greater responsibilities do so because of the human, rather than the technical, aspects of the job.

Men who are accustomed to dealing with instruments, predictable responses, or precise qualities of materials often fail to realize that men present problems which differ from engineering apparatus, in that dimensions are not so exact, reactions have infinite variability, and tolerances are much broader. Engineers, thus, are not as generally aware of mishandled people as they are of misused equipment. To place this failing in its correct perspective, consider the balance between the technical and human relations requirements of management jobs. Even at the lower level of management, technical requirements do not often exceed 50% of the job. The remainder is concerned with getting things accomplished through people. As one moves up the management echelon, the emphasis swings further and further away from the technical and more and more towards "people" relations. At a top management level—even in the engineering area—requirements are no more than 10% technical, with the remaining 90% resting upon human relations. Thus, the major function of most management jobs is getting results through people, and yet it is precisely in this area that the engineer exhibits his greatest weakness. Therefore, appraisal must be carefully keyed to discovery of the human relations abilities in engineers.

In consideration of long-range potential, it should be realized that analytical ability is a major factor in engineering jobs. There is no substitute for the ability to assess a problem, divide it into its major and minor implications, judge its balance, and reach a logical and practical decision. Research shows a direct relationship between level of positions and level of intelligence.* In this particular respect, the selection of engineering managers is easier. The rigorous requirements of an engineering curriculum plus a work experience which places a premium on analytical ability almost assures that a management candidate chosen from a group of engineers will have the necessary intellectual stature to fill upper positions effectively. Yet, nonetheless, appraisal should be attuned to evaluating this all-important mental quality in engineers.

Now to bring to focus these appraisal standards, we need to look at engineers against the precise requirements of jobs they are to fill, rather than concentrate so heavily on position functions now held. In addition, for manpower planning purposes, the long view needs to be accented. In this sense, human relations abilities and intellectual competence are the critical ingredients.

* Characteristics of Promotable Executives. Management Research Publication, Booz, Allen & Hamilton, New York, N. Y.

EFFECTIVE APPRAISAL

BEFORE PARTICULAR TECHNIQUES of engineering evaluation are discussed, it may be desirable to describe some of the characteristics of a sound appraisal program, which tend to make the process effective in any company in any industry.

Tailoring to Company Needs. In most circumstances a company is ill advised to adopt an appraisal program shaped for general usage or for particular application in another company. Engineering groups have different problems and different personalities. To be most effective, appraisal should be tailored to the group to be appraised. Only in this fashion can it serve its optimum purpose.

Periodic Appraisal. Engineers change significantly, particularly at lower levels and younger ages. A proper appraisal program is repeated at intervals of at least once a year and more often in problem situations or when filling key positions. It is only in the repetitive evaluation situation that convergence upon the "right answer" is accomplished. It is only under periodic appraisal that we have a "moving" picture of the engineer and can note his progress and development. The appraisal process is not intended as a static device to fix one's status in the organization permanently.

Simplicity. More appraisal programs break because of engendered suspicions, doubts, and low credence than for most other reasons. Each engineer should know what is happening in the appraisal process and the role he is to play. The program should be carefully explained to him and all questions answered *before* its initiation. The engineer should fully understand its mechanics, its purpose, and its implications. Evaluation can be truly effective only under these circumstances.

Assessment of Potentials. As previously mentioned, this provides the basis for adequate manpower planning, promotion, compensation, transfer, or special assignment.

Multiple Appraisal Techniques. Up to the limits imposed by practicality, the more evaluative the techniques brought to bear on the engineer, the greater the likelihood of accurate results. Though popular and more used than any other approach, supervisory appraisal has too large a margin of error to be tolerated. The error area is significantly shrunk by using multiple appraisal methods, each making its own contribution to the total evaluation.

Not only should one use several appraisal techniques or approaches, but each should be different so that no part of the engineer is left in the "dark" zone. Approaching appraisal from several different angles and sides exposes more and better information on the engineer. The best results are not obtained by interviewing a person four times but rather by integrating interviews with three other and different techniques.

Cross-Checking and Confirmation. The appraisal approaches should be chosen in such manner that they can be integrated, and in such fashion as to allow cross-checking of results. Results found from the use of one technique should either be supported by those derived from another approach or discarded. Only confirmed evaluative findings should be used. Information obtained from several different sources makes this possible.

Direct and Relative Appraisal. One should use an evaluative approach which measures an engineer against the requirements both of the current position and the one to be held. Thus, he is being evaluated in terms of the absolutes of his job situation. But also, and most importantly, he must be compared with others in the engineering structure, for all are in competition with each other for more important responsibilities in the engineering structure. Therefore, both direct and relative appraisal are necessary to a balanced point of view.

Basis for Development. Appraisal will disclose the weaknesses or "gaps" which an engineer possesses as measured against job standards or management requirements. These weaknesses should be made the specific objective of an engineering training and development program. In this fashion, realism is built into the development program—a point of major neglect in most such activities.

Formal Evaluation Procedures. The basic premise here is that appraisal evidence and results be recorded in such fashion that any reasonably intelligent person can go through the accumulated facts and arrive at the same decision as the appraiser. The "tracks" must be so clear that virtually anyone can follow the trail. This is the acid test of the correctness and validity of evaluative findings.

Keeping Results Confidential. It is superficially evident that an appraisal program can be effectively killed by letting results become public property. The bridge of confidence so necessary to "accepted" results is totally destroyed by such activity.

Reporting Results. There is a strongly implied obligation to present the final appraisal results to the person who was evaluated. There is no way this step can be avoided if one is looking for maximum results. This should be done through the normal supervisory-subordinate relationship. It is not a staff task and it cannot be delegated. Either alternative saps the strength of the appraisal result and voids the normal prevailing pattern of relationship in the business.

PROGRAM PARTS

A COMPLETE PROGRAM for appraisal consists of four basic elements: personal background information, internal appraisals by company management, personnel tests, and personnel interviews. Each segment contributes to the summary appraisal for each individual. In total, these parts provide opportunity for extensive cross-checks to confirm the reported results. Let us examine the role of each segment of the program.

Personnel Information Summary. The purposes of such a summary are to indicate actual and potential areas of competence, to indicate the past pattern of recognition and accomplishment, and to indicate leadership qualities. The summary contains, essentially, a documentation of the person's education and training, complete work experience, and participation in outside associations. The information should be assembled from personnel records and by direct interview.

A penetrating analysis of a person's history and record often provides an explanation for his present status and important clues as to his probable future growth. It indicates his interests and his willingness to put forth effort for the sake of personal growth and development. Moreover, it provides a pattern as to his ability to accept responsibility and to assume leadership positions.

Interpretation of the engineer's background in terms of relative progress and accomplishments should also be made. The purpose is to highlight the areas of business competency, length of service and the rate of past recognition. Inasmuch as the achievement pattern of an individual has a distinct tendency to continue, this summary gives a broad indication of potential.

Internal Company Appraisal. The persons most competent to make appraisal judgments of an engineer are those who have known him best in his working environment—the persons who have worked with him over a period of years. For various reasons, the task of securing an objective, meaningful evaluation from business associates is a difficult one. However, if a means is devised to secure an appraisal, it is likely to be more valid and more valuable than any other appraisal device brought to bear on the individual.

The internal company appraisal described covers three areas: position performance, mental qualifications, and human relations. Company appraisals have, in the past, characteristically leaned very heavily on position performance, a useful but incomplete appraisal tool. Mental qualifications embracing the ability to cope with unusual situations, to develop new ideas and improved methods, to think through complex problems, and to grasp quickly the significance of a situation, have been difficult to measure and, consequently, have been neglected by company appraisals in the past. The importance of human relations has been receiving growing attention in the last several years, but generally their measurement has been inadequate.

In this appraisal, the three—position performance, mental qualifications, and human relations—are merged and used as measures of management potential. This technique greatly improves the validity and thoroughness of the appraisal.

To achieve accurate and useful appraisal results, a forced-choice type of appraisal is employed. Other types of ratings have not yielded the same high degree of validity as has been achieved by this type of approach. Here the person is forced to provide a definitive and discriminatory evaluation. It forces identification of the characteristics of an individual making for success or failure as an engineer. It provides for categorical appraisal decisions rather than vague generalities. The tangible results of the evaluation, thus, are improved.

The usual company internal rating system relies to a very significant degree on the judgment of the immediate supervisor or, in better systems, upon a committee evaluation. It is recognized that some supervisors are good judges of people and others are rather poor. The engineer being appraised thus is often victimized by poor judgment. In the committee system of internal appraisal, the end results usually are a compromise of viewpoints and often reflect the thinking of the most dominant member of the committee. Thus, in either the supervisory or the committee system of internal company evaluation of management personnel, the results have less than desirable validity, primarily because of the subjective influences present.

The appraisal here rests upon the principle that a majority opinion of a group of appraisers, each of whom engages in a completely independent evaluation, possesses far more validity than either of the two widely used systems described. Up to a point, the greater the number of qualified appraisers brought to bear upon an individual, the better the opportunity for confirming appraisal judgments and eliminating the bias and subjectivity present in other systems.

Statistical verification shows that when five appraisers are used, the appraisal findings are significantly more valid than for three, and that when four appraisers are used, the appraisers are often split two and two as to judgments and it becomes necessary to choose arbitrarily one judgment over the other. Hence, the present concept of the internal company appraisal involves five appraisers. The use of more than five appraisers cannot be justified either statistically or in terms of practical circumstances.

As an ideal situation, the appraisers should be made up of (1) The immediate supervisor; (2) The supervisor's supervisor; (3) One person at or above the position of the person to be appraised and within the appraisee's department; and (4) Two persons at or above the position of the person to be appraised and within other departments with which the person to be appraised has worked closely.

The idea involved in the selection of raters along the suggested lines is to provide as many valid appraisals from as many possible angles as can be reasonably achieved. It does not appear possible to secure a high percentage of objective, valid ratings from positions below that of the person to be appraised. Typical appraisals originating at a lower level may generally be divided into two classes: those that shade the appraisal to curry favor of the person being appraised, and those that are critical and biting rather than constructive. Hence, it seems wise to avoid the selection of appraisers at a lower level than the management person being appraised.

Two other qualifications appear essential in the persons chosen as appraisers. First, they should have known the person on a working relationship basis rather than on a purely social basis. Second, the raters should have known the person rated for at least a year.

It is realized that the qualifications of the appraisers represent a standard toward which one should work. Individual circumstances may dictate other choices or divergence from the standard. It is urged, however, that the appraisers be chosen as nearly as possible in line with the suggested qualifications. Otherwise, the validity of the appraisals may be injured.

Personnel Tests. These tests are basically valuable in the appraisal of engineers. Perhaps their primary asset is providing information that otherwise would be difficult and sometimes impossible to obtain. Examples of this are: gauging a person's basic intelligence, discovering his knowledge of proper principles of supervision, or identifying fundamental interests. It is very difficult, for example, to determine the basic mental quality of a person if he speaks about his position and work accomplishment in which he has a strong background of experience. Such a person would show a "high face validity" and would seem quite intelligent. Removed from highly familiar surroundings and environment, he might show to considerably less advantage.

A second value of testing is diagnostic. The test results point to appraisal areas needing further investigation. The need for close scrutiny by other evaluative methods is accented. Finally, testing is useful, as an integrated part of the program, in confirming findings arising from the other parts of the program. As previously mentioned, high appraisal validity comes from confirmation of results. Tests provide a useful confirming device.

There are a number of acceptable tests on the market than can easily be fitted into the program. Whatever tests are used, however, should meet certain requirements. In general, tests should

1. Be proved valid by continued industry usage
2. Be capable of being integrated with the other program parts
3. Give best possible results with minimum time expenditure
4. Cover the basic abilities and personal qualities valuable to engineering appraisal.

Tests generally should cover intelligence, interests, and temperament. Where supervisory jobs are being considered, a supervisory knowledge test can be included.

In addition, tests should be interpreted by a fully qualified and experienced person. The best norms for this purpose are those built for the engineering group. Research shows, beyond doubt, that test performance tends to vary more by the functional area involved than on any other basis.

Personnel Interviews. There are several purposes behind the interview. First, the interview can supply appraisal facts not otherwise obtainable. In this category would be included such things as personal appearance, poise, mental organization, verbal facility, or breadth of interest. Second, the interview can be used as a means of answering questions or clearing areas of doubt that have arisen as a result of other program parts. Finally, the interview is useful in confirming or verifying findings derived from other segments of the appraisal program. The interview is, thus, a basic and valuable evaluation tool if correctly used.

As an ideal situation, all persons in the appraisal program should be interviewed. Morale deficits are thereby minimized and a uniform measurement of all persons is achieved. In many cases, it may be desirable to interview fewer than this number. In that event, a screening should be invoked, using the other three parts of the program through which all persons have gone.

The success of an interview is largely dependent upon the person doing the interviewing. In this appraisal system, the ideal method is to use personnel trained in interviewing, use as few interviewers as possible, and have the person doing the interview write up the appraisal for the people that he has interviewed.

In terms of information needed, it is dangerous to interview on an extemporaneous basis. This lack of planning will usually result in incomplete appraisal findings. Furthermore, the interviewee will often be aware of the lack of interview planning and organization and will lose confidence in the appraisal itself. To be most effective, definite procedures should be observed.

There are certain things that need to be learned from the interview, such as mental organization, poise, and analytical approach to problems, all of which should be listed. In addition, certain questions that need to be cleared up will have arisen from other segments of the appraisal program, and should be listed. Then there will be other program findings that need to be confirmed. These also should be listed. A combination of these three listings constitutes the objectives or target for the interview.

Keeping these objectives in mind, specific questions should be planned that will bring out the information desired. Five or six questions should be set up for each of the objectives sought. These should be committed to memory. If one question fails to bring out the answers desired, another can be utilized. Preplanning of topics and questions assures meeting interview objectives as well as bringing a uniform appraisal approach to each person in the program.

THE APPRAISAL REPORT

THE EXTENSIVE CROSS-CHECKING is valuable for increasing the accuracy and dependability of the appraisals. It is of value also in the insight and understanding which it provides. What may appear to management as basic, unalterable weakness have been found in a number of cases to be something which may be subject to change through development.

The appraisal findings derived under such confirmation procedures are then written up in a narrative appraisal. This narrative appraisal is divided into four sections, the content of which is discussed in the following paragraphs. There is, of course, variation from this content pattern, where necessary, to bring out the information pertinent to the appraisal of any one person.

Management Qualifications. The management qualifications represent a summary of the individual's strong and weak points in relation to his present position, and in relation to his potential in the engineering organization.

The first paragraph provides the background information, summing up what the person has done in terms of education, work experience, and memberships in outside associations. It provides a perspective of where the person now stands in terms of achievement, both as to type and level.

The second paragraph appraises the person's mental qualifications from the standpoint of those at his present level and higher.

The third paragraph brings out the person's interests; personality traits; supervisory, administrative, and managerial abilities; and human relations abilities.

Management Potential. This section identifies the area in which it is judged that the person can be successful. It indicates the highest level of management for which the person appears to have potential, naming positions, where possible, to which the person can reasonably aspire by virtue of his apparent basic abilities.

Position Eligibility. Listed in this section are the positions which the person is now ready to fill. In some cases, this may indicate he is not ready for promotion. In others, it is the position next in line, indicating he is ready for promotion now. In still others, it is a position involving a lateral move, indicating an eligibility should there be a need.

Development Needs. This section lists those needs which are apparent from the appraisal, but it includes only those in which there is reasonable expectation of development. Furthermore, in many instances, it suggests actual development methods as a guide to the planning of individual programs.

As the conclusion of the appraisal summary, each man is given an index of potentiality. A suggested method of establishing such an index is provided in the next paragraph.

An engineer may be rated for present potential as

1. Ready for promotion now
2. Ready for promotion with some further training and experience
3. Requiring considerable training and experience before promotion
4. Not appearing to possess promotional possibilities.

He may be rated for ultimate potential as

1. Possessing the potentiality for executive positions
2. Possessing the potentiality for junior executive positions
3. Possessing the potentiality for middle management positions
4. Possessing the potentiality for senior professional engineering positions
5. Possessing the potentiality for junior professional engineering positions only.

These indexes, with their appropriate color code, can be used in a wide variety of charts, tables, and graphs to show the capabilities of the present engineering staff against the needs of the company.

SUMMARY

THERE IS NO QUESTION that our demands for engineers greatly exceed our available and foreseeable supply. Therefore we must do everything within our power to make the best use of our available talent.

We must carefully select and appraise our engineering staff in order to put the right man in the job and to build our staff for the bigger jobs of tomorrow.

To appraise both our newcomers and our experienced men, we must have an objective system of evaluation. This system consists of (1) A factual personnel summary, (2) Multiple appraisals by superiors and associates, (3) Tests, and (4) Personal interviews.

The results of these four parts to the appraisal program can be summarized in a convenient appraisal form, which highlights strengths and weaknesses of each individual under consideration. The requirements can then be matched against available resources and the manpower requirements and development program can be planned accordingly.

In-Flight Refueling

The first successful in-flight refueling of one supersonic jet fighter by another has been completed high above this Mojave Desert air base by two North American Aviation, Inc., F-100 Super Sabres.

The "Buddy System," in which one jet carries extra fuel for another, permits added range and an increased bomb load. One fighter trails a hose and drogue from an external pod and pumps fuel from its tank to another fighter. After the fuel transfer, the "tanker" plane can return to its base while the other fighter can fly on to a distant target. The system permits two fighters to fly out together and refuel at their normal high speeds and altitude. Thus, the fighter which is to continue on avoids the loss of range encountered when it must come down to a larger tanker's lower speed and altitude.

Load Tap Changer Capability Tests

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IN THE DESIGN of load tap changer mechanisms for large power and regulating transformers, the possibility of their operation during system short-circuits is an important design consideration. Interrupting tests to determine the capability for such operation are necessary in order that the switch may be properly applied.

In changing transformer tap connections it is necessary to maintain continuity of the current path and at the same time avoid short-circuiting the transformer tap during the transition. In all load tap changing systems resistors or reactors are used to limit the tap circulating current to a manageable value while permitting continuous flow of load current without excessive voltage drop in the impedance. The differences between the reactor and resistor systems result from the fact that it is not practical to make the resistors large enough to carry the current except for very brief periods. For this reason, resistance type switches are always designed to complete the entire sequence in a few cycles and usually are operated by a spring. Switches using the reactor system of bridging may be spring operated or direct cam operated. If the switch is inadvertently stopped at other than a true tap position, the reactor will not be damaged inasmuch as it is usually designed for continuous operation on any switch position.

The contactor recovery voltage is the phasor sum of the tap section voltage and the impedance drop of the system fault current in the switching impedance. It is apparent that the recovery voltage as well as the interrupted current increase at heavy overloads. The ultimate limit on the maximum short-time overload that can occur is a system short circuit at the terminals of the transformer of the maximum value permitted by transformer standards. This current, together with the characteristics of the impedance, establishes the maximum interrupting duty which the tap changing equipment can encounter in service. Although a switching reactor is designed to be essentially linear at normal load currents it will become saturated at heavy overloads. Because the recovery voltage at the zero current point has the greatest bearing on current interruption, it is apparent that saturation of the reactor may have only a small benefit in improving the ability of the contactor to interrupt current. The greatest benefit from saturation is obtained with contactor designs which by double-break or other means introduce sufficient arc resistance into the contactor circuit to shift the current zero with respect to the reactor peak recovery voltage. This reduces the instantaneous recovery voltage and allows insulation build-up across the arc path immediately following current zero and before the recovery voltage peak occurs.

Failure to interrupt an arc in a contactor might result in a fault to ground or between phases within the switch compartment building up explosive pressures resulting in oil fire. The arc might also be transferred to the tap selectors resulting in tap-to-tap or tap range faults short-circuiting parts of the transformer winding.

When spring driven mechanisms are used, an uninterrupted arc produces a tap-to-tap short circuit even though the new connection is successfully established. Whether the tap section short circuit builds up to a destructive full scale tap-to-tap short circuit depends on the tap section voltage, the overload current being interrupted and the impedance of the tap section to the source of power.

When it is considered that interruption of normal current takes place in a cycle or less and that system faults may be cleared in 10 cycles or less, it may seem that the probability of simultaneous occurrence of system faults and tap changes is quite remote. If reasonable numbers are assumed for the frequency of system short-circuits and for tap-changer operations, only a small proportion of the tap changer will be called upon to operate during a system short circuit in the lifetime of the transformer.

Overload rating tests of a given contactor design may be made independently of the complete tap changing transformer by using circuits and test loads reasonably equivalent to those to which the equipment would be subjected in actual service. Inasmuch as system fault current is predominantly reactive, the power factor and the magnitude of the normal load current may be ignored, and an essentially zero power-factor load used in the tests.

Contactor designs for which a benefit results from the saturating characteristic of the reactor may be tested with a circuit giving a peaked wave shape recovery voltage. The contactor switches load current, limited by a linear reactor, into a saturating reactor in parallel with its contacts. This test circuit requires a very high kva power source because only a small part of the kva is utilized in the rupturing duty test of the contactor.

Tests to evaluate spring operated switches are made in two steps. First the ability to interrupt the arc without drawing a tap short circuit is determined similarly to other types of switches. A test is then performed to determine for which combinations of tap section voltage and impedance and striking currents a full tap-to-tap short circuit will build up.

By applying the switch such that the tap changer interrupting duty resulting from occasional system faults does not exceed the capability of the switch as demonstrated by type tests, the transformer and switch are protected from any possibility of damage.

Digest of paper 57-48, "Short Circuit Capability Tests of Load Tap Changer Mechanisms," recommended by the AIEE Committee on Transformers and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N. Y., Jan. 21-25, 1957. Published in AIEE *Power Apparatus and Systems*, April 1957.

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Scientific Instrumentation in IGY Satellites

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Possibilities for experimental instrumentation in connection with the International Geophysical Year satellites are discussed. A number of experiments appear to satisfy the acceptance criteria for inclusion in the first group of satellites. Certain others may qualify for later satellites if slight relaxations on weight and configuration are permitted.

THERE ARE two categories of satellite experiments. One group involves only ground-based observations of orbital parameters and their rates of change. Such observations should yield hitherto unattainable information about atmospheric densities, the geodetic figure of the earth, and intercontinental distances. The second group involves actively instrumented satellites with data transmission by radiotelemetering. Suitable experiments in most cases resemble those which have been flown in high-altitude rockets during the past ten years. If only higher altitude data were being sought, vertically fired rockets would be far simpler vehicles for the purpose than orbiting satellites. A satellite, however, possesses the special advantage of permitting measurements of greatly extended duration. Short-lived emissions of ionizing radiation associated with solar activity, which have never been measured in spite of numerous attempts with rockets, can be almost certainly detected from a satellite. Similarly, the data needed to analyze the composition of the primary cosmic ray spectrum or the distribution of meteoritic particles, and other low intensity phenomena can only be accumulated in the lifetime of a satellite experiment. Finally, the geographic spread of satellite measurements will permit the latitude and longitude as well as altitude dependence of the above phenomena to be analyzed and will afford possibilities of studying world-wide meteorological conditions.

Fig. 1. Ion chamber for detection of Lyman alpha radiation (1215.7 A.U.).

Experiments selected to be flown in the satellite program should be designed to take advantage of the full lifetime of the satellite and the great geographical coverage of the orbit. Both the flight time and the life of the power supply in the Vanguard satellite are limited by the capacity of the rocket system, whose estimated capability is to place a 21.5-pound payload in an orbit at 300 miles. Of this 21.5 pounds, approximately half the weight goes into structure of the sphere and supporting members. The remainder is distributed between the Minitrack transmitter, telemetering, the experiment itself, and power supply for about 500 hours of operation. The experiment must be designed within the boundary conditions of 2 or 3 pounds total weight and less than 100 milliwatts power consumption.

The severity of the weight limitation can be appreciated from the fact that each added pound of payload reduces the terminal velocity by 100 feet per second, which in turn costs about 33 miles of altitude. Solar cells offer promise of extending the lifetime of the power supply, but even their weight cannot yet be accommodated. Present estimates are that a solar storage battery could produce 5 watts continuously for a year, but it would cost 10 pounds. Geographical coverage could be increased by increasing the inclination of the orbit, but this also requires greater performance from the rockets to compensate for the loss of the velocity component derived from the earth's rotation.

Many proposals for satellite experiments were presented at the UARRP (Upper Atmosphere Rocket Research Panel) Symposium on the Earth Satellite held at the University of Michigan in January 1956. All of these proposals were experiments of unquestionably high scientific importance, but many failed to meet the size and weight limitations of the Vanguard satellite. A few experiments, at this time, appear to satisfy the acceptance criteria of scientific importance and technical feasibility for inclusion in the first group of satellites. Certain others could qualify if comparatively slight relaxations on weight and configuration requirements were

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Fig. 2. Electrometer circuit associated with Lyman alpha ion chamber.

permitted. These will most likely be flown in later satellites.

TEMPERATURE

In designing satellite experiments it is necessary to know the environmental conditions in which the instrumentation must perform. Several environmental in-flight measurements will be made. The satellite temperature will be controlled largely by absorption of visible light and reradiation of visual and infrared light. Heat transfer from the extremely thin air will be negligible and the dissipation of internal power will be kept to a low value. In daylight the temperature will rise because the sphere absorbs direct sunlight, sunlight reflected from the earth, and infrared emission from the earth. When on the dark side, the satellite will receive only heat radiations from the earth and its temperature will drop. The temperature balance on the surface and within the satellite will depend on the ratio of energy absorbed to energy reradiated and the heat capacity of the sphere and its contents.

If the metallic surface were highly polished, it would reflect a maximum amount of visible light, which would be advantageous for optical tracking. But a highly reflecting metallic surface would result in too high an average temperature for satisfactory transistor operation. Some temperature control can be derived by optically coating the surface. If silicon monoxide is evaporated onto the sphere, it is possible to balance the visual spectrum absorptivity and the infrared emissivity in such a way as to obtain a more favorable average temperature, high enough for satisfactory battery performance yet not too hot for transistors. For example, a surface which has an absorption coefficient of 20% for the visible spectrum and an emissivity of 10% for the infrared would produce excursions of shell temperature between −40 C and 75 C with a mean value of 20 C.

The internal electronic package, of course, would not follow the extremes of surface temperatures because of its large heat capacity. Additional control of the internal package temperature is possible by means of heat switches connecting it to the shell. These may be bimetallic strips which open and close like thermostats to regulate the heat flow between the shell and the electronic package. It appears that the internal package temperature can be held constant within ±5 C.

To check the performance of the satellite in flight, several thermistors will be mounted on the skin and on the instrumentation package.

METEORS

Meteor measurements are also included in the environmental experiment.

Most meteors are extremely small, the large members of the showers being increasingly scarce. The only example of a giant crater-producing meteor during the present century has been the Siberian Meteorite of 1908. During each 24-hour period, it is estimated that less than a dozen meteorites reach ground level. Several million meteors a tenth of an inch or so in diameter enter the air per day, and the largest of these accounts for the visible shooting stars. Many phenomena associated with meteors are of profound scientific interest. Nighttime E region and sporadic E may both be the result of meteor ionization. Meteors may contribute some of the characteristic emissions of the air glow. Meteors may also constitute an erosion and puncture hazard to the satellite. It is believed that meteoritic particles no bigger than 100 microns in diameter and traveling at 50 kilometers per second can puncture a sheet of duraluminum, 0.020 inch thick.

Both visual counts and radio reflections from meteor trails fail to detect meteors weighing less than about 10^{-4} grams. It is estimated that approximately one ton of extraterrestrial material composed of particles larger than this minimum size is accumulated by the earth per day. A much greater number of smaller particles, "micrometeorites," steadily fall into the atmosphere. The estimated daily accretion is about 1,000 tons. The frequency of hits on the satellite, the size distribution, and the velocity of the impacting particles will determine the extent of damage from skin erosion and the puncture probability. The hazard of meteor penetration is very difficult to estimate. According to estimates based on visual observations, the time interval between penetrating hits would be several thousand days and the probability of such a hit during a period of two to three weeks would be less than one chance in a hundred. Other estimates derived from theories of the zodiacal dust would indicate an appreciable probability of penetration in the same

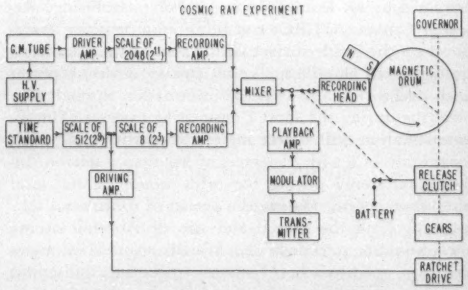

Fig. 3. Block diagram of cosmic ray experiment.

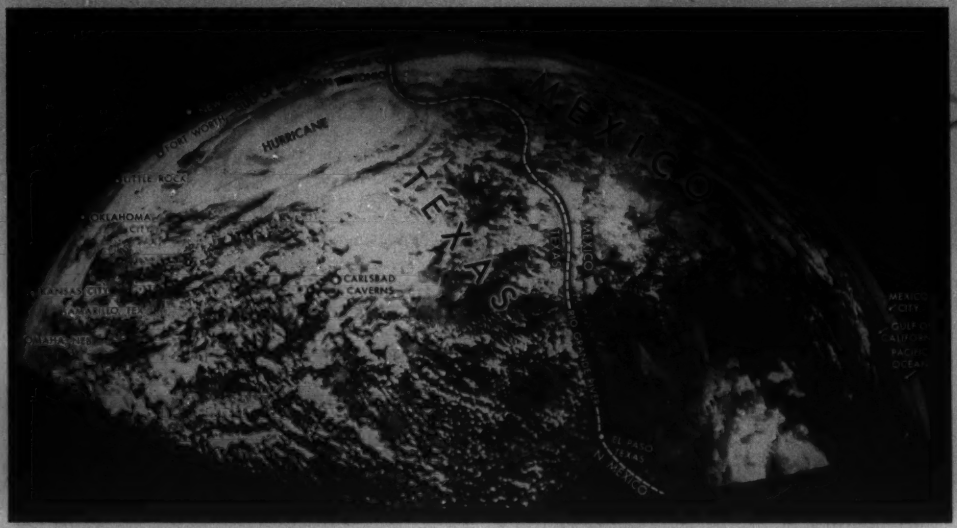

Fig. 4. Picture reconstructed from photographs taken in rocket over White Sands Proving Ground, N. Mex., showing development of hurricane.

period. Since puncture of a sealed sphere can be measured with a simple aneroid pressure gauge, it seems desirable to include such detection in the satellite. By providing more than one sealed compartment, a correspondingly higher number of punctures can be detected.

Hits by meteorites have been counted in rocket experiments by detection of acoustic energy generated on impact. The acoustic method employs one or more microphone pick-ups, and amplifiers tuned to bands in the ultrasonic range from 30 to 60 kc. A transient pulse generated by meteoritic impact would be most easily detected by a tuned amplifier and crystal microphone having peak responses at the same frequencies. Such a sensing device can be lightly tapped with a pencil and show little response, yet will produce a sharp voltage signal when struck by a grain of sand dropped from a height of 1 inch.

A satellite version of the meteor experiment has been proposed by M. Dubin of the Air Force Cambridge Research Center (AFCRC) consisting of a sensitive transducer on the inside surface of the skin of the satellite, a transistorized amplifier, a count storage device, a power pack, and a switch to feed the information through telemetering during the short transmitting interval. The instrumentation will detect meteoritic particles of visual magnitude +25 with diameters of less than a micron. Information stored during the orbit would be the total number of counts. During the period of continuous telemetering both the spatial and size distribution of impacts would be recorded. The AFCRC proposal estimates the total weight to be 41 ounces, including the crystal transducer, amplifier, battery packs, and storage circuitry. The operating lifetime would be about 30 days.

S. F. Singer of the University of Maryland proposes to measure erosion of the satellite surface by incorporating a radioactive tracer in a portion of the skin. A Geiger counter mounted beneath the surface would detect the loss of material by erosion as a decrease in counting rate.

H. E. LaGow of the U. S. Naval Research Laboratory has designed resistance strips in the form of evaporated films on thin glass supports to be cemented to the surface of the satellite. Erosion would increase the resistance which is readily measurable.

SATELLITE ASTRONOMY

The sun radiates all wave lengths from cosmic rays to radio waves. Most of the radiation reaches us as visible light and some can be detected at ground level by devices sensitive to near ultraviolet and infrared. The great range of wave lengths which do not reach ground level accounts for all of the ionosphere and contains vital information to the understanding of astrophysical phenomena.

Astrophysicists and astronomers are looking forward to the day when observatories will be carried in satellites far above the obscuring and blurring layers of the earth's atmosphere. Over the past 10 years, rocket experiments have given the first direct view of the solar spectrum beyond the ground level cutoff at 2,850 A. U. From spectrographic and photon counter measurements we now know the general shape of the sun spectrum all the way down to X-ray wavelengths of a few angstrom units. But the sum total of all rocket measurements adds up to less than an hour of useful observations. The most interesting features of the solar picture are those associated with violent activity such as solar flares. Such events occur infre-

quently and at random. Furthermore, a flare develops very rapidly, reaching the peak of the flash phase in a matter of 5 or 10 minutes. To catch the spectrum of such short-lived phenomena is a tremendously difficult task with conventional rocketry. A satellite offers the nearest approach to a continuous observing station above the atmosphere.

The hydrogen Lyman alpha line at 1,215.7 A.U. is the most prominent feature of the far ultraviolet solar spectrum. It is absorbed in the earth's atmosphere between 90 and 70 kilometers, the D-region ionosphere. The flare intensity of Lyman alpha may be orders of magnitude greater than its bux from the entire disk under quiet conditions. Since "sudden ionospheric disturbances" are directly associated with solar flares, Lyman alpha emission is expected to play a key role in such effects as radio fadeout.

A satellite experiment can monitor the sun in Lyman alpha almost continuously for many days and would be worth hundreds of randomly fired rockets for the same purpose. During the period of maximum solar activity in 1957 and 1958, the chances of observing a flare of Class 3 magnitude will be quite good and numerous smaller flares will certainly occur during a satellite lifetime.

A very simple technique has been developed for measuring the intensity of Lyman alpha radiation electronically Figs. 1 and 2), The detector is an ionization chamber sensitive to a narrow band of wavelengths centered about the Lyman alpha line. Its spectral sensitivity is derived from photoionization of nitric oxide gas with which it is filled. The threshold of ionization occurs at 1,340 A.U. On the short wavelength side the response is limited by the opacity of the lithium fluoride window below 1,100 A.U. Between these two wavelength boundaries more than 95% of the solar radiation is concentrated in the Lyman alpha line.

One of these chambers mounted with its window exposed through the skin of the satellite will observe the direct radiation from the sun some time during each roll period. Since telemetering stations are to be located along one meridian, information can be obtained from the satellite for only a few seconds out of each orbit. The instrumentation will include circuitry for storing the peak signal of the Lyman alpha chamber during each revolution of the satellite around the earth. Solar aspect (angle between direction of the sun and the normal to the window of the chamber) will be provided by a simple photocell.

A memory device, developed by N. W. Matthews and his co-workers at the U. S. Naval Research Laboratory, will store the peak signal developed during each orbit. The basic element is a magnetic core in which the flux level is a function of the peak value of current flowing in the input winding. This core is the frequency-controlling element in an oscillator circuit which modulates the transmitter for the "Minitrack" system.

There is considerable evidence of intense X-ray emission during a flare. Some of the observed ionospheric effects of strong flares, such as the marked drop in base of D layer revealed by the method of sudden phase anomaly, can be better explained by an X-ray flare than an ultraviolet flare. To measure such X rays, all that is required is to substitute a beryllium window for the lithium fluoride window in the ion chamber and to fill the tube with argon rather than nitric oxide. The ideal experiment for the satellite would include both ultraviolet and X-ray detection.

COSMIC RAYS

Cosmic rays can be studied in satellites with equipments similar to those that have been flown in rockets and balloons. The simplest experiment involves the use of a single Geiger counter to study the geographical and temporal variations of the primary intensity. During the orbit of the satellite, information would be stored in a magnetic memory circuit and then read out rapidly over the telemetering ground station.

A detailed description of a satellite cosmic ray experiment has been offered by G. H. Ludwig and J. A. Van Allen of the State University of Iowa. The output of the Geiger counter is counted over a period of minutes until a predetermined number of counts is reached. Simultaneously with the last count, a pulse is recorded on a magnetic drum which also carries a time base. Over a telemetering receiving station, the instrumentation is keyed by signal from the ground and a rapid play-back is started. After read-out the drum returns to its starting position and the previously recorded data is erased. Fig. 3 shows a block diagram of the Iowa State proposed experiment. Binary scalers count up to 2,048 and pass the last pulse to the magnetic drum. A similar arrangement produces one pulse every 8 seconds from the time standard oscillator. The drum steps once per second and makes one revolution in 200 minutes.

The expected counting rates are such that a pulse will be recorded once every 205 seconds when the satellite is crossing the geomagnetic equator and about once every 41 seconds near a geomagnetic latitude of 40 degrees. At this rate each orbit will contain about 50 segments of cosmic ray counting rates. From such data it will be possible to derive more accurate information than is now available about (1) the geographical distribution of intensity, (2) the orientation of the geomagnetic field, (3) the relative strengths of terrestrial and interplanetary magnetic fields, (4) the cosmic ray albedo, and (5) temporal variations. The total weight of the equipment minus power supply would be about 1.7 pounds. With a power consumption of 81 milliwatts, a battery capacity of 40 watt-hours is required for about 3 weeks of operation. Using silver cells, the battery weight requirement amounts to about 15 ounces.

MAGNETIC MEASUREMENTS

A portion of the earth's magnetic field measured at ground level is produced by current systems in the ionosphere. It is believed that the major effects are attributable to currents flowing near the base of the E region. Another current system may exist in the form of the "Chapman-Stormer" current ring encircling the

earth in an equatorial belt at a distance of several earth radii. Their theory predicts that as a stream of charged particles from the sun approaches the earth, it is deflected by the earth's magnetic field and sweeps around the earth to form the ring current. Variations in the ring current should produce corresponding variations in the resultant magnetic field strength at the surface of the earth. Supporters of the ring-current theory believe that it can account for the sudden commencement of magnetic storms and the subsequent positive and negative excursions of the change in horizontal field component over a period of several days.

Total field measurements made in the satellite above the E and F ionosphere regions could resolve the question of whether the changes in the earth's field during magnetic storms are due to ionospheric currents or to an extraterrestrial ring current. For the experiment to succeed, it is necessary to know the satellite altitude very accurately and to measure simultaneously the earth's field at the ground. A suitable magnetometer would be a lightweight version of the proton precession magnetometer manufactured by Varian Associates that has already been flown in rocket experiments.

METEOROLOGY

THE PICTURE in Fig. 4 was obtained from an Aerobee rocket fired to a height of 100 miles above White Sands Proving Ground in New Mexico. Scientists from the Naval Research Laboratory equipped the rocket with two motion picture cameras looking out of the tail at the landscapes of New Mexico and Texas. The picture was actually reconstructed from a hundred scanning frames exposed during the sweeping yaw and spin of the rocket. It presents dramatically a full picture of the cyclonic clouds which shortly later released the flash floods of October 4, 1954, on Brownsville, Texas, and Roswell, N. Mex. These clouds were so high that they completely escaped the observations of weathermen on the ground.

A satellite station far above the earth may ultimately provide detailed pictures of complete tropospheric weather systems covering areas as large as the entire United States. At the present stage of the art of satellite observations, however, the best that can be done is to devise simple photoelectric instruments to measure the distribution of cloud cover. Clouds provide the clearest evidence of the patterns of motion in the air and the variations of temperature and moisture content in different levels of the atmosphere. A photocell located in a spin-oriented satellite could get a continuous picture of the earth's albedo on a global scale, and thereby measure the solar energy input everywhere on the earth's surface. More than that, it could locate large cloud areas and report on their development and motion from hour to hour. Such observations would be of inestimable value to meteorologists concerned with the large-scale motion of the atmosphere and with calculations of heat balance and energy transfer in the atmosphere.

W. G. Stroud of the Signal Corps Engineering Laboratories has described an experiment to measure the albedo of the earth with an arrangement of photocells. The albedo of typical surfaces varies from as low as 3% for sea water to 85% for fresh snow. Dry earth, grass, and rock have albedos varying from 10 to 33%, and clouds from 50 to 75%. To determine cloud distribution from albedo measurements, it is necessary to scan the radiation reflected from portions of the earth and to determine at each instant the exact orientation of the satellite with reference to the earth. Stroud proposes to use a set of three photocells speed 120 degrees apart around a circular cross-section of the satellite. Each photocell aperture will see a field about 5 degrees wide. As the satellite spins, each photocell sweeps a curved path across the earth's surface from horizon to horizon. By comparison of the relative lengths of the sweeps of the three detectors, it is possible to derive the orientation of the satellite and to identify the scanned regions on the earth. If the perigee and apogee are 200 and 800 miles, respectively, the center path will cover a zone approximately 15 miles wide by 2,500 miles in length at the perigee and 60 miles by 4,600 miles at the apogee. The data storage and telemetry for this experiment would be somewhat more complex than is required for the other experiments described.

CONCLUSION

THE EXPERIMENTS which will be accepted for flight must meet the specifications of the Vanguard satellite in which 2 to 3 pounds is available for the experiment, including detectors and their circuitry, telemetering modulator to feed Minitrack, and power supply for all these items. Of the group described, the environmental, Lyman alpha, meteorite, and cosmic ray experiments appear capable of currently meeting the requirements. The magnetometer and albedo experiments are examples of somewhat more complex proposals which may be suitable for satellites with greater payload capacity.

Radar Mapping Device

Details of a novel device, the "Radar Restitutor," have been announced by the Electronics Division of Fairchild Controls Corporation, subsidiary of Fairchild Camera and Instrument Corporation.

Photographs of radar displays contain many distortions and inaccuracies, making them unsuitable for measuring distances between points on the ground. The chief distortion on the radar photographs is caused by the fact that radar records the distance between the radar station and an object, and for airborne radar sets this means that the slant distance is recorded. For mapping purposes, however, the ground distance between the aircraft nadir and the ground object must be known. In addition, an airborne radar is continuously moving, and the radar display does not take this motion into consideration. The Restitutor computes these distortions, as well as several others, and positions the ground object at the corrected co-ordinates on the new photograph which it produces.

Response of Relay Amplifiers with Feedback

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THE RELAY AMPLIFIER with feedback is a simple and economical solution to many power amplification problems. The configuration of the primitive relay amplifier is shown in Fig. 1. The relay is assumed to have both deadband and hysteresis as shown. Inasmuch as the low-pass filter is the only predominant lag in the feedback, it might be surmised that the relay amplifier is stable under normal conditions and indeed this may be shown.

The operation of the amplifier may be described by referring to the waveshapes given in Fig. 2. It is assumed that a step function of voltage E_r is applied to the input at time t_0. It is assumed that initially there is no charge on the capacitor and that the relay is open. The capacitor begins to charge along the usual exponential to E_r volts. However, at e_2 volts the deadband voltage of the relay is exceeded and the relay closes to E_b volts. Now as the result of the action of the subtractor, the capacitor begins to charge down to $E_r - E_b$ volts. When the capacitor voltage reaches e_1 volts, the relay opens and the capacitor must once again charge toward E_r volts, and the process repeats itself. During the period that the relay is closed, a pulse of E_b volts is present at the output and is applied to the load.

The response of the amplifier obviously is not a faithful reproduction of the input step function. However, it may be shown that the average value of the output pulses is essentially linearly related to the input magnitude. Thus, if the load presents a smoothing or low-pass filter effect, its response would be an adequate representation of the input wave. Because most of the loads driven by power amplifiers do incorporate the low-pass effect, the relay amplifier is quite generally useful. The relation for the average output voltage may be found to be

$$\bar{e}_m = \frac{E_b \ln \left[\dfrac{1 - \dfrac{e_1}{E_r - E_b}}{1 - \dfrac{e_2}{E_r - E_b}} \right]}{\ln \left[\dfrac{1 - \dfrac{E_b}{E_r - e_1}}{1 - \dfrac{E_b}{E_r - e_2}} \right]} \qquad (1)$$

where the symbols are as defined in Fig. 2.

The frequency response of the relay amplifier is found to depend upon the amplitude of the input signal. However, as an approximation, it may be said that the response is generally flat to about the break frequency of the low-pass filter. The frequency response of the amplifier may be improved up to a point by raising the break frequency of the filter. If the filter frequency is made too high, however, the other lags in the loop that could previously be neglected, such as the time constant of the relay coil and the time required for the relay to close, cause the amplifier to become unstable.

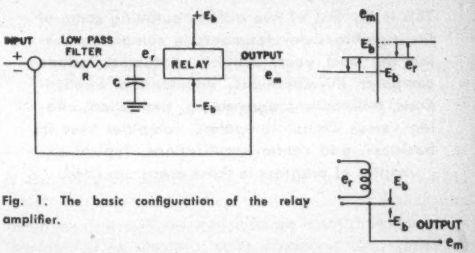

Fig. 1. The basic configuration of the relay amplifier.

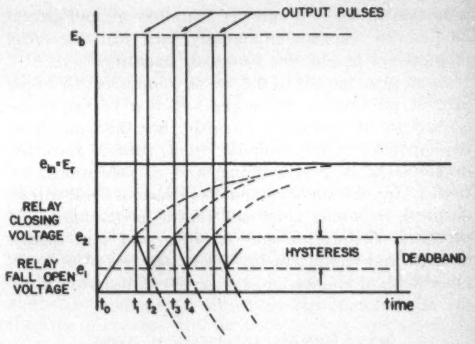

Fig. 2. Voltage wave shapes in response to a step-function input.

CONCLUSION

THE OPERATION of the relay amplifier has been discussed and has been shown to be satisfactory for loads that incorporate a low-pass filter effect. The relay amplifier may be shown to be stable for the usual values of the filter time constant. The static response is a linear function of input step magnitude and the sinusoidal frequency response has been determined. The responses are normalized to deadband and hysteresis so that the results may be applied to any configuration. The responses derived are independent of the type of load driven.

Digest of paper 57-183, recommended by the AIEE Committee on Feedback Control Systems and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N. Y., Jan. 21-25, 1957. Scheduled for publication in AIEE *Applications and Industry*, 1957.

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The Computing Revolution

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This is the first of two articles outlining some of the significant developments in computing during the past year. Subjects discussed include computer developments, engineering applications, automatic programming, simulation, analog versus digital computers, computer uses in business, and control applications. Typical examples of progress in these areas are cited.

COMPUTING PROGRESS in electrical engineering is an integral part of a revolution in information processing, paced by a 10-to-1 increase per year in automatic computing power. The consequent reduction in the unit cost per computation, and greater adaptability, expands enormously, each year, the range of problems feasible for automatic handling.

As an introduction to the use of computers, the broad field of information processing will first be briefly described. It will be done by discussing first the most recent developments in the computer itself, then in turn, the development in programming, and in professional activities. Application of computers in various fields will be outlined, including automatic control of machines and processes, engineering and research, and very briefly, business and manufacturing. These are typical of many other fields of application, and serve to illustrate further the revolutionary nature of this development.

MAN'S MENTAL AND PHYSICAL WORK

WITHOUT GOING INTO the fine distinctions between work and play, it can be said that the purpose of computing or information processing equipment is to reduce man's work, or to amplify through automation the work that he does do, in producing the necessities and luxuries of life. We find two closely paralleling developments of information processing, the one associated with man's mental or clerical work and the other tied in with the machines that do his physical work. Referring to Table I, in his mental and clerical work we can identify at least four distinct stages starting with the dask calculators, adding machines, and cash registers which were simply aids to calculations.

Table I. Computers Aid Man's Work

Mental and Clerical Work	Physical Work
1. Desk Calculator, Adding Machine, Cash Register	1. The Tool
2. Business Machine	2. The Power Tool
3. Large-Scale Computer	3. The Automatically Controlled Power Tool
4. Self Programmed Computer (Automatic Programming)	4. The Automatic Factory or System—Optimizing Controls

Next came the business machine on which simple calculations could be programmed and executed on large numbers of similar documents. This was followed by the large-scale internally programmed computer which could be directed through a long sequence of engineering, scientific, or business calculations. These machines brought a new era of drastically reduced unit cost per operation. This is being used in business through the substitution of complete machine handling of many jobs, replacing clerical forces and lesser machine aids. However, very detailed instructions by the programmer are necessary and programming presents a serious bottleneck in the application of these machines.

The next logical stage of development, therefore, is in the field of automatic programming to make the machine respond very powerfully to comparatively simple commands. Automatic programming ideas are developing very rapidly and already many of them are in use, but the developments of the next few years will undoubtedly bring great advances in the automatically programmed computer, throwing more of the burden on the machine. In addition, there will be larger memories, which aid the programming problem, and higher speeds which lower the unit computing cost and permit computations heretofore uneconomic.

In the realm of physical work, man started with the tool, with man providing both the power and the intelligence. Then he applied power, producing the power tool, but with man still providing all of the intelligence. Next came the automatically controlled power tool with much of the direct intelligence for the immediate job built into the machine, usually in the form of analog computing devices. However, much of the planning and programming for the operation remained with the man. Next came the program controlled tool or automatic factory in which a complete sequence of operations would be controlled, and in which the elements of process optimizing are beginning to appear. The computer or data processing portions of the system are beginning to emerge as a distinct organ of the machine, whose functions are recognized as separate and distinct from the power handling functions. It requires little imagination to realize the vast potentialities in this direction that remain practically unexplored as the power of mechanized logic and computer developments are brought to bear on sequencing and optimizing controlled processes.

It is the purpose of this paper to explore these two paths in the progress of computing, from many different angles which, together, convey some idea of the revolutionary nature of information processing developments.

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However, its true purpose is not to amaze, but rather to acquaint the reader with significant facts which will bring into focus this extraordinary development, and to aid him in judging its use and implications in his particular field of endeavor.

ADVANCES IN THE MACHINES

THERE IS NO EVIDENCE that the 10-to-1 increase per year in computing power measured by the speed, size of fast memory, power of command, flexibility, and reliability is diminishing, or will in the foreseeable future (Fig. 1). The consequent reduction in the unit cost per computation, and greater adaptability, expands enormously the range of problems feasible and economic for automatic handling. As shown in Fig. 2, a computation requiring two weeks on a desk calculator and costing $300 only a few years ago, now costs three cents on a high powered computer, a reduction of 100,000 to 1. In 1956, highlights of the advance were the general use of magnetic core memories and commercial computing speeds of 40,000 additions per second. There were several solutions to the large random access memory problem in the Univac file computer, Burrough data file, and IBM Ramac. The file computer is a multiple drum computer providing large drum storage. The Ramac unit is a disc memory operating in the fashion of a juke box and storing some 6 million six-bit characters. Some 60,000 100-character records are individually addressed. The average access time to individual records is ½ second, while in reading information serially from one of the discs, the transfer rate is about 250 characters per second. The data file is a 500-million-bit random-access unit containing 100 tapes and a movable head. Individually addressed records are reached by positioning the head as well as the individual tape.

The old saying that "where there is a will, there is a way" is proving out in this area of storing vast quantities of information needed for frequent access. The access time does not need to be a few microseconds as in the high speed memory of a computer. Hundreds of milliseconds are permissible, but the cost per bit must be low to provide economic applications.

Another important area of development is the use of solid-state techniques. Several all-transistor digital computers have now been constructed and many computers now in production use magnetic core memories. Thyratron-like transistors have been developed for controlling the electromechanical elements of input–output equipment. These radical departures from the all-electronic tube computers of only a few years ago are of tremendous importance not only in the reliability, but also in the size and air conditioning requirements and capabilities for expansion to larger computing capacity.

Under this category also must be mentioned the "Cryatron" which employs a magnetic field to switch a supercooled wire "in" and "out" of superconductivity. One can hardly imagine cheaper element than a tiny length of wire with another small wire wound upon it. One hundred of these can be placed in a thimble. A complication

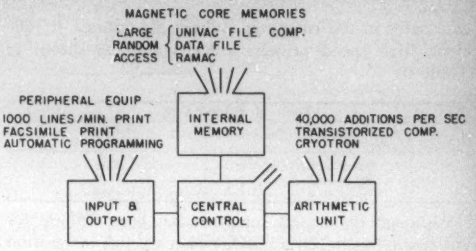

Fig. 1. Digital computer developments in 1956.

is the refrigerating unit to produce the liquid helium which holds them at 420 degrees below zero at which temperature they are superconducting until influenced by the controlling magnetic field. However, this refrigerating unit appears practical in many applications and for expendable computers, a small tank of liquid helium refrigerates the small space inexpensively. The first computer using these new logic elements is now under construction by Arthur D. Little Co. working with Massachusetts Institute of Technology engineers.

To match the high speed of the computers, printers have now been developed up to 1,000 lines-per-minute (2,000 characters per second, IBM), and facsimile printing on RCA's new Bizmac (registered trade mark) is at this same rate of 2,000 characters per second. The magnetic tape reading and writing rates, when the tape is one character wide (six useful bits wide), is 15,000 characters per second or roughly 7½ times the best printer. Several of the latest computers provide for simultaneous reading and writing on several channels which further multiply the tape advantage, and for both business and scientific purposes, on the largest machines, it is now becoming the practice to use magnetic tape input and output. Binary storage of numerical information on tape increases the storage efficiency about 67% with an equivalent increase in reading and writing speeds.

With tape input and output, the information to be processed is put on tapes, and from tapes to printers,

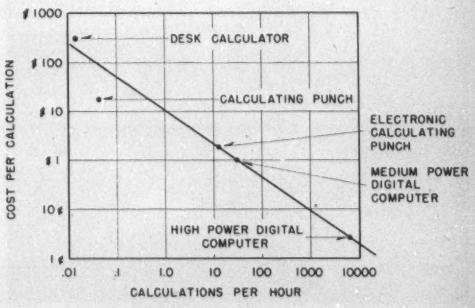

Fig. 2. Computation cost vs computer speed.

externally to the computer. Where the volume is sufficient, high speed printers are economic as shown in Table II.

Table II. Printer Cost

Lines per Minute	Cost per 1,000 Lines
150	$1.00
500	0.63
1,000	0.58

Although the digital computer has been utilized for automatic control for a number of years, full integration did not take place until 1956 when a number of applications in production use and extremely widespread uses under development, supplementing analog computers in this area, were made.

Analog computers, although somewhat outstarred by their digital cousins, have also made very substantial advances during 1956 with the emergence of the economic dispatch computers, large simulation installations, and widespread use of electronic analog computers.

No less significant than individual developments is the mass usage of both medium and high power computers during 1956. Tremendous developments in automatic programming and user organizations to share the programming effort on a national scale makes the 10-to-1 growth rate per year seem a particularly conservative estimate for 1956. These realities of 1956, taken in the light of existing advanced defense developments of computers, and the announced plans of computer companies, "Stretch" and "Larc," leave no doubt as to the revolutionary state of this art.

PROFESSIONAL ACTIVITY

PROFESSIONAL INTEREST in this enterprise is centered in the joint sponsors of the Joint Computer Conferences, the Association for Computing Machinery (ACM), the Professional Group on Electronic Computers of the Institute of Radio Engineers (IRE), and the Committee on Computing Devices of the AIEE. The Joint Computer Conferences of which two are held each year, have grown from an attendance of less than 1,000 at their inception about four years ago to well over 3,000 at the most recent meetings. In addition, at the recent AIEE general meeting, computer sessions were held on four of the five days, six sessions altogether, involving about 25 papers. Similar interest is found in the IRE meetings and the ACM meetings are devoted primarily to computer utilization. Professional computer meetings are also being scheduled in the American Society of Mechanical Engineers, American Management Association, American Society of Chemical Engineers, Society for Experimental Stress Analysis and many others as well as dozens of forums and courses each year held by various schools and manufacturers who are interested in the development of computers and automation.

This should not be unexpected since information processing expands and supplements man's mental efforts in the same way that the application of power from our natural resources supplements his physical labors. The limits to which automatic information processing may be advantageously carried are absolutely unpredictable at the present time.

Fig. 3. View of an economic dispatch computer for electric power systems.

AUTOMATIC PROGRAMMING—SHARE OPERATIONS

AS POINTED OUT in connection with Table I, the large scale internally programmed automatic computer, made it possible to carry out complete sequences of engineering design or business data processing problems. However, they also entailed a tremendous programming job of writing all of the detailed instructions necessary to make these machines perform the desired tasks. The industry was totally unprepared for this tremendous task and it, more than any other one thing, has slowed down the application. While production capacity for computers has been a bottleneck, it is likely that even this could have been stepped up had the programming then been able to keep pace with the demands.

From the start, there has been a strong urge to do something about this programming bottleneck. Actually, very great progress has been made and those responsible for the many new concepts and philosophies are to be highly commended in spite of the fact that there is a tremendous job still ahead.

The systems which have evolved when listed in increasing order of sophistication and power, are defined as follows:

The Interpretive Program. A number of subroutines for common operations are prepared and fed into the computer [or wired in the case of the card-programmed calculator (CPC)]. The program for an individual job is then written calling up these subroutines by name wherever required and avoiding rewriting them for individual problems. For the CPC, it was usual to use 10 subroutines for add, subtract, multiply, divide, sine, cosine, arc sine, square root, logarithm, and exponential. The arithmetic operations were double precision, floating point. This means that although the arithmetic unit in the CPC was a five-digit machine, all results were carried out to eight digits with the appropriate power of 10 carried along automatically to avoid all scaling problems.

Assembly Program. An assembly program is a package program which brings to the programmer most of the

features of automatic programming available to date. It enables the programmer to write the program with an easily remembered list of short words or nicknames for the operations that can be performed either basically by the computer or that can be interpreted by the assembly program. Also, in writing this program, the programmer can refer to symbols by their letter designations rather than by the machine address of the location where the quantity is stored. Having written his program in this symbolic form, the programmer takes it to the computer to be assembled using the assembly program, which, in the typical case of the IBM *704*, then performs on it all of the following functions:

AUTOMATIC PROGRAMMING FEATURES
IN USE WITH THE *704* COMPUTER

1. Automatic Translation—from the programmer's language to the machine language. CLA, which means CLear and Add, is converted by the *704* to 000 101 000 000 000.
2. Automatic Library Reference—from a single instruction "Sin Lib," the *704* brings the sine routine from its library tape. Similarly for all common routines.
3. Automatic Allocation—of memory space and insertion of proper addresses in all instructions.
4. Automatic Detection—of common programmer errors.
5. Automatic Conversion—from our decimal number system to the *704* binary number system.
6. Automatic Condensation—of the program from one step per card to 22 steps per card for machine economy.
7. Automatic Floating Point Arithmetic—built in features of the *704;* keeps track of the decimal point position.
8. Automatic Formula Translation—with the Fortran system, the *704* generates its own program from the algebraic expressions written by the programmer.
9. Share—in addition to cost reduction by automatic programming, the *704* users organizations has "Shared" the effort on over $1 million worth of programs.

NOTE: Features 1 through 6 are provided by the Share assembly program.

This Share assembly program has been adopted in common by some 80 users of the *704* computer throughout the country. All write their programs so that they can be assembled by this "Share" assembler and so that the programs so prepared can be interchanged and all users will understand the common mnemonic language adopted.

Compiler Program. The compiler program goes a lot farther than the assembly program and actually prepares automatically a program from the mathematical description of the problem to be performed. An example is the Fortran system for the IBM *704*, Fortran meaning "formula translation" into a computer program. This produces a machine language program with an average efficiency of about 10 machine language steps prepared by the compiler for every mathematical instruction written. This efficiency carries through to the reduction of debugging effort as well as original programming. Another example is the program IT, a compiler written for the IBM *650* medium power computer. Programs written in the abbreviated or mathematical languages for the IT or Fortran program compilers, can be translated by computer from one to the other. Programs for this translation are now being written from the Fortran language to the IT language and vice versa. This will provide for the first time the possibility of programming a problem and compiling automatically highly efficient programs for running it on more than one computer.

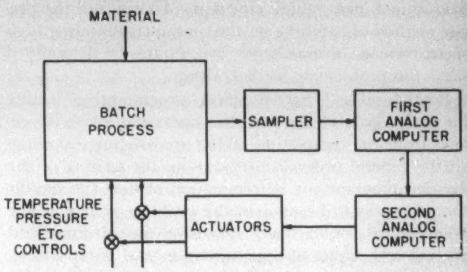

Fig. 4. Example of computer control for a batch process of hydrogenation of cottonseed oil.

PROGRAMMING STATUS DEFINED

THE TERM "programming" is used by many installations to include all preparation work up to the actual production running of problems on a computer. Others divide the effort into analysis, programming, and coding with possibly debugging as a fourth category. Where these distinctions are made, the intent is somewhat as follows:

Analysis. Here the problem is analyzed to determine how it can be put on the computer. Usually it is necessary to know what computer or computers are available because the extent and manner of handling the problem will vary somewhat with the available computer. For example, iterative loops in the main program are not possible on a CPC. Large matrix inversions required frequently in a problem are not economically feasible on medium power computers. The analysis may require determination of an entirely different procedure than any used prior to computer handling. For example, design of machines has historically been largely a ratioing, checking, and changing procedure from previous designs. But this requires so much individual handling, ingenuity, and judgment that in changing to a computer method, it has been necessary to go back to fundamentals and design each machine from scratch, taking into account the basic materials, standard parts, and manufacturing facilities available. This is feasible because of the high speed of the computer and provides a sounder method, not relying on the vagaries of other designs. It also introduces the concept of optimizing to a greater extent each unit designed, rather than merely meeting specifications with a reasonably optimum design. Thus, the analysis phase may require several months or even years in the case of complex problems for determining a suitable computer method or general flow plan of calculations to arrive at the required answer. Although there is much variability and overlapping, the analysis stage may be said to be complete with the production of a complete flow diagram of the calculations. However, at this stage, a detailed flow diagram cannot be made because the size of

subroutines, data tables, etc., is not known and the precise method of handling on the computer allocating high speed memory, drums, tapes, etc., cannot be determined until the problem is further along.

Programming. Where the term "programming" is used for only a part of the complete operation, it would extend from the completion of the analysis stage through all the general program preparation, the writing of the detailed program and determination of how the specific computer was to be used in the problem at hand. The programmer would make extensive use of numerical analysis techniques of approximation and curve fitting, methods of solving any simultaneous equations or differential equations involved, and the algorithm or method of solution for sorting, selecting, or optimizing problems. The analyst would decide to solve certain equations in the procedure. The programmer would decide how to do this and program it.

Coding. Once the programming job is well under way, there may be extensive parts of the program which have been quite completely defined as to the exact process to be carried out and a complete flow diagram available so that it is merely a matter of translating this form of expression, that is, flow diagrams, equations, etc., into the computer language or assembly program language. This level of programming is often called coding to distinguish it from the more involved parts of the programming operation. Coding can be done automatically by a compiler program.

Debugging. The debugging process involves essentially two procedures. First is the correcting of all mistakes in the program proper so that the program when run on the computer executes exactly the steps intended. The second part is more involved and requires feeding back clear to the sources of the work the computed results for typical cases to determine whether the entire method is satisfactory for the work intended. In the case of design of transformers or induction motors, this may require careful check over a period of time and numerous changes and modifications and improvements in the method until there is sufficient satisfaction with the results of the automatic computer method to put it into full scale use. This second phase of debugging is largely missing in the case of mathematical routines such as simultaneous equations, extraction of roots, etc., where a program either does or does not solve the problem correctly and once the intended routine is carried out, the job is done. Even here, however, such matters as approximation and curve fitting require considerable numerical testing for proof of adequacy.

Program Maintenance. To complete this picture, one must mention program maintenance after the program is in use, making modifications or improvements and additions. The building block or subroutine approach to problems attempts to keep the various phases of a design computation distinct and separate so that it can be improved or altered without having to look at all the rest of the program. For example, the computation of costs could be improved if an improved costs reporting technique is installed in the factory. An improved loss calculation might be developed or an improved optimizing procedure, or it may be decided to carry the program a lot farther into the preparation of much more information on the design than originally intended.

Program Translation. Also, with the rapid advance in computing power, it may be economical over-all to change an entire computing load to a newer, higher powered computer, which can perform the over-all operation for less total cost, as well as making it possible to perform many information processing operations heretofore impossible. In this event, the problem of translating earlier programs may be a substantial economic and manpower factor. For programs written in a compiler language which can then be translated automatically and recompiled for the new computer, this problem is minimized. However, frequently program improvements desired are so extensive as to require practically a new program anyway, and also existing compilers can handle only a part of the total programming work required on large design problems at present and practically none of the work required on business problems. Consequently, the problem of program translation from computer to computer is one crying for better solution than any available at present.

AUTOMATIC CONTROL OF MACHINES AND PROCESSES

As POINTED OUT in connection with Table I, computers are by no means new in automatic controls. Computing techniques have been used from the earliest days. For example, consider the analog type of data processing involved in feedback control systems with derivative feedback, addition and subtraction of quantities, etc. Likewise, digital techniques have been common in the relay logic systems that determine under what conditions various devices operate. The new progress is in the field of extensive computer control where the computer comes out as a distinct organ or a major information processing operation. A few examples will be cited.

Prima donna of the computer controls in the machine tool industry is the digitally controlled contour milling machine of which several are now in experimental use in the aviation industry and approximately 140 are on order for delivery within the next two years. Computation of the necessary tool path becomes a separate problem for a centralized computer which can then serve several digitally controlled tools. This is typical of a host of applications of digital positioning and sequencing devices for a wide variety of purposes.

Another example is the command computer for a missile system in which the guidance commands are computed from observed data. This is but one of a family of computers for various fire control, aircraft guidance, and navigational purposes in which the information processing operation is so extensive as to require a high speed electronic computer integrated into the process.

The economic dispatch computers for electric power systems, analog computing devices which determine the

economic dispatch of generation and actuate the load control system to effect this proportioning, are the forerunners of a family of optimizing computers for all purposes, where economy plays an important role. The dispatch computer shown in Fig. 3 provides information to the operator for economic dispatching, but is arranged for automatic operation with the load control system when installed.

The Westinghouse Automex (registered trade mark) system (automatic experimenter) determines by small perturbation experiments on a continually operating system, the optimum adjustment of a multiple control system to optimize any desired quantity or function. This represents one approach to process controls where the complete defining relationships between control and output are not known, but is not limited to this case inasmuch as knowledge of the relationship between measured quantities and control is capitalized to improve the correction toward the optimum.

In an experiment at Case Institute of Technology in Cleveland, Ohio, sponsored jointly by Westinghouse and a number of other companies, a batch process of hydrogenation of cottonseed oil was investigated for a computer control, an analog computer being selected in this case. The purpose was to optimize the production by making the process proceed to its final state in the shortest time and to provide better control of the final desired mix of products. Both of these were achieved by a combined computer control illustrated in Fig. 4 which breaks down into two general functions. First, the equations describing the process were nonlinear and were considered linearized at a particular stage of the process. The coefficients of the linearized equations were obtained by sampling at five minute intervals and solving simultaneous equations to determine the necessary coefficients of the linearized equations to fit the last several samples.

Next, with these linearized equations and a second portion of the computer, the parameters were swept over the adjustable range and the process integrated through to the end on this basis to determine the optimum adjustments at that stage to obtain the best production rate with the desired controlled end-product mix. The success of this experiment establishes a milestone in the application of computers to process controls.

The variety of requirements of industrial digital controls requires a flexible building block approach for providing any kind of logic from simple adders and counters or memory devices up to full-scale computers. The Nor circuits and Nordic computer system provides this flexible building block approach and is being engineered into industrial controls for steel and many other industries.

Cypak is a building block approach utilizing magnetic static elements to replace relays in logic systems for industrial automation. It affords reliable digital control unimpaired by large numbers of operations, because there are no moving parts in the information processing parts of the system.

These examples serve to illustrate the lines of progress being made in industrial automation with computers and data processing devices. However, they hardly convey the enthusiasm and hope with which the industry is encouraging these applications, which make it possible to program for automatic application much of the information which now exists more as an art than as a science.

(In the July issue of *Electrical Engineering*, the author discusses the computer as an engineering and research tool, and its growing use in business and manufacturing.)

Video Transmission Via Ordinary Telephone Cable

Results of experiments which, for the first time, make feasible the transmission of narrow band television pictures with motion over ordinary telephone cable pairs were revealed in a speech given before the Franklin Institute of Philadelphia, Pa., by C. R. Kraus of the Bell Telephone Company of Pennsylvania.

Mr. Kraus detailed the research and development work which had been conducted by his company in co-operation with two manufacturers of industrial television equipment, General Precision Laboratory Incorporated (GPL), Pleasantville, N. Y., and Dage Television Division of Thompson Products Inc., Michigan City, Ind., in the field of narrow band television employing a frequency bandwidth of only 25,000 cycles. This compares with the 4 million cycle bandwidth required for present methods of transmission over special video cable. The new system utilizes standard telephone cable facilities for transmission and operates successfully distances from 10 to 15 miles. Further development work, Mr. Kraus indicated, possibly could extend the range of transmission even further.

Although the lowering of frequency results in pictures of somewhat less resolution than in regular broadcast transmission, they are of sufficiently acceptable quality to be used for a variety of industrial applications such as traffic control and banking operations where picture quality is not of primary consideration. In viewing street traffic flow, Mr. Kraus pointed out, it is necessary to see only the vehicles, not the ripples in their fenders. Furthermore, the current requirement for expensive video cable, microwave equipment, or coaxial cable is avoided with this system.

With the success of these experiments, important economies and resulting widened markets for closed-circuit television are envisioned, in as much as there are only some 15,000 video conductor miles in the Bell System compared with approximately 235 million miles of ordinary cable conductors.

Distribution System Load Characteristics

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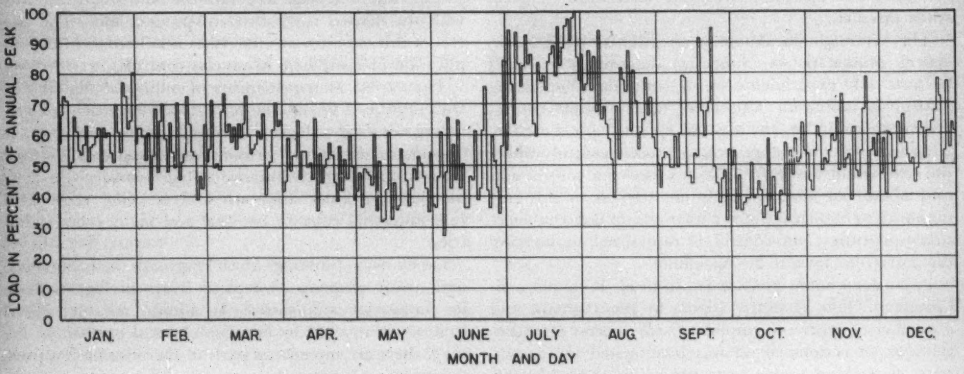

Fig. 1. Daily maximum loads for a typical distribution transformer.

INASMUCH AS the sole purpose for the existence of an electrical distribution system lies in supplying the requirements of the consumer's utilization devices, it is fundamental that a knowledge of these load requirements is necessary for sound planning of the distribution system and its various components. The economic importance of the knowledge of load characteristics has become more and more recognized with the growth of load on utility systems. In recent years, much work has been done in this field. Many utilities have made and are continuing to make, in some form, surveys of the load on their systems. Information obtained from utility load surveys can be used for many purposes other than distribution system planning and optimum equipment design. Often, data from the same load survey is used in studies of rate structure, cost analysis, and development of "selective selling" programs.

One of the most useful survey methods for determining load characteristics is the method of group load surveys. Test groups are selected on the basis of homogeneity of character and use, predominance of one class and convenient layout of distribution lines for test metering. If the test groups are selected as being representative of their class, the load survey data can have a broad application. An example of a residential group load survey consisting of 48 similar residential test groups is summarized here. The groups consist of varying size in order to provide coincidence-factor information. An indicating 15-minute interval-kilowatt demand meter is installed at each residence. Graphic type demand meters are installed in order to measure the combined kilowatt and reactive kilovolt-ampere demand for each group.

In addition to daily load curves, an analysis of this data furnishes the following: a correlation between the kilowatt-hour (kw-hr) usage of an individual consumer and his peak demand, coincidence factor relationship, loss and power-factor information, and load factor data.

Loads on currently installed distribution transformers can be estimated by using the kw-hr vs demand relationship, and coincidence-factors obtained from the load survey. The load of the individual customers served by the transformer is estimated from the graph relating kw-hr usage during a given period to the peak demand within that same period. Application of the appropriate coincidence factor provides an estimate of the peak load supplied by the transformer.

Safe overloads for distribution transformers can be determined from an analysis of the daily load curves of the various test groups. The frequency of occurrence of the peak-load condition is of great significance (Fig. 1).

A knowledge of load characteristics is important not only to the utility, but also to the utility industry supplier. If load characteristic information which is sufficiently representative for the entire electrical utility industry could be obtained, it might serve as the basis for evaluating the over-all economics of design changes in equipment such as distribution transformers. These design changes could, in turn, provide greater operating economy to the utility.

Digest of paper 57-168, "Distribution System Load Characteristics and Their Use in Planning and Design," recommended by the AIEE Committee on Transmission and Distribution and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N. Y., Jan. 21-25, 1957. Scheduled for publication in AIEE *Power Apparatus and Systems*.

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Diesel Locomotives for Lightweight Passenger Trains

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FOR MANY YEARS the railroads have been operating their passenger business at a loss. The railroads, as well as locomotive and car builders, have studied this problem to see what could be done to turn the loss into a profit. The findings of the study have resulted in designing and building a new type of passenger car and locomotive. The cars are lower in initial cost, are lighter in weight and require less power to haul them, have a lower center of gravity, and have been designed to require less maintenance.

A new locomotive designed for passenger service has been built to haul these cars. It provides head-end power for the cars, is lighter in weight, will require less maintenance, and uses a hydraulic transmission.

There are two diesel engines on this locomotive. The traction engine, rated 1,000 hp, is mounted on the front truck and delivers all of its power to the rails through a Mechydro* hydraulic transmission having four speeds forward and four reverse. The engine and transmission have been in service on German railways where they have established a record of low maintenance costs, low engine fuel consumption, and high availability. An auxiliary engine, rated 570 hp, is mounted in the body of the locomotive and drives a 300-kw a-c generator and air compressor. The a-c generator provides power for all of the locomotive auxiliaries and for train heat, light, and air conditioning.

The locomotive is 58 feet 9 inches long, 10 feet wide, 11 feet high, and weighs 193,000 pounds. The front truck is a 4-wheel self-contained power package having the diesel engine, hydraulic transmission, drive shafts, axle drives, and sand boxes all mounted on it. A 4-wheel idler truck is at the rear.

The transmission is located beneath the cab floor and is accessible through trap doors. Directly behind the cab is a compartment in which the traction engine is located. A radiator fan in the roof blows air down into the compartment and pressurizes it. The auxiliary engine and generator, air compressor, electrical equipment cabinets, fuel oil tank, and battery box are in the center of the locomotive. At the rear end are located the fans and radiators for cooling the engines and transmission, and the water pumps. A special coupler, installed at the rear end of the locomotive, contains the air brake and forty-two 75-volt d-c electric connections. When the couplers are locked together, all connections are made automatically. Three a-c train power contacts are located on top of the coupler frame and mate automatically.

The main engine is a 12-cylinder 4-cycle "V" type, rated 1,000 horsepower at 1,500 rpm. It weighs about 11,000 pounds. Among the differences between this and other V-type engines are the use of turbocharger intercoolers to cool the air before entering the engine, the shorter length, and the use of large diameter roller bearings for main bearings instead of conventional friction bearings.

The Mechydro transmission is fully automatic. It consists of a permanently filled single-stage torque converter; three pairs of permanently meshed helical gears, engaged by special claw clutches to give four output speeds; forward and reverse gears, plus control equipment; all housed in a single oil-tight casing. Power from the engine to the transmission is through direct-connected universal shafting. The impeller of the torque converter is driven through step-up gearing, thus obtaining a high rotational speed of the converter and smaller internal parts. The oil in the transmission is cooled by a heat exchanger using water from the main-engine circulating system.

Continuous tractive effort is 21,000 pounds at 12.6 miles per hour. Maximum speed is 120 miles per hour. The oil-filled converter permits an immediate response when the throttle is advanced. Operation of the controls in the transmission is automatic and is controlled by two governors. One governor is driven by the engine while the other is driven by the output shaft of the transmission, and its speed is proportional to locomotive speed. The governors are linked together, so that at certain speed differentials the claw clutches will operate to make either an upward or downward shift.

All of the locomotive auxiliaries, with the exception of the air compressor, are motor driven. They receive their power from the 300-kw 480-volt 3-phase 60-cycle generator that supplies power to the train. Use of standard voltage and frequency in the electrical system has permitted the use of commercially available squirrel-cage motors and controls. These items are lighter and less expensive than special railroad equipment. All locomotive control circuits are 75 volts d-c.

The engine and generator are mounted on a common sub-base. It is supported on the locomotive frame by flexible rubber mounts to reduce vibration. The belt-driven d-c exciter is mounted above the generator. A magnetic amplifier type voltage regulator is installed.

Direct current for battery charging, locomotive lighting, and control circuits is obtained from the a-c generator through a step-down transformer and a 3-phase full-wave germanium rectifier.

Digest of paper 57-30, "Diesel Locomotives with Mechydro Hydraulic Transmission for Lightweight Passenger Trains," recommended by the AIEE Committee on Land Transportation and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N.Y., Jan. 21-25, 1957. Scheduled for publication in AIEE *Applications and Industry*, 1957.

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* Registered trade mark

Television Allocation Trends

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A brief review is presented of television allocation developments since 1945 and an outline is given of the effect of the developments in the television broadcast service on the present rules of the Federal Communications Commission. Future developments are predicted using the past 10 years as a guide.

IN MID 1945 six commercial and three experimental television broadcast stations were furnishing a limited television service in restricted areas of the country. Today there are 487 television stations of which 391 operate in the vhf portion of the spectrum (30-300 mc), on channels 2 through 13 and 96 operate in the uhf frequency range (300-3,000 mc), on channels 14 through 83. From less than 10,000 receiving sets in service 10 years ago, current estimates indicate 35 million receivers in operation serving in excess of 90% of the population. Technological advances in television spurred by wartime effort brought commercial operation out of the experimental category of prewar years and underwrote its growth as a powerful entertainment, education, and merchandising tool by 1948.

In 1945, 13 six-mc channels between 44 and 216 mc were available for immediate postwar television broadcasting. In addition, the band from 480 to 920 mc was provided for experimental television broadcasting looking toward the future establishment of a quality television service in this range. Fig. 1 portrays in somewhat simplified fashion the division of the radio frequency spectrum between 30 and 3,000 mc among various services at the present time. The breakdown of available frequency bands between the broadcasting, aeronautical, amateur, Government, safety and special, and other miscellaneous services is shown. Just 20 years ago, most of the frequencies above 30 mc were designated for experimental operation. Technological progress and accumulated knowledge of propagation concerning frequencies higher than 30 mc, since that time, has led to the usage indicated by the chart. Their general suitability for broadcasting and communication relying upon the space radio wave without, for the most part, interfering contributions by skywave propagation have rendered it ideal for services within generally well-defined ranges out to the order of 50-100 miles. Today, in addition, the "scatter" mode of propagation is assuming considerable importance in certain portions of this frequency range. Thus, r-f channels within this portion of the spectrum are for the most part at a premium with greater demands yet to be imposed.

Essentially full text of a conference paper presented at the AIEE Fall General Meeting, Chicago, Ill., Oct. 1-5, 1956. Recommended for publication by the AIEE Committee on Television and Aural Broadcasting Systems.

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RELATIVE DIVISION OF R-F SPECTRUM

THE BAR CHART SHOWN IN FIG. 2 is based upon the assignment pattern of Fig. 1 and illustrates the relative division of this portion of the spectrum among the various services. The simplification referred to previously is mainly in the area of biasing Fig. 2 toward showing somewhat more allocation space in the Government area than is actually the case. Areas of operation such as meteorological and international control frequencies have been lumped into the Government area. It should be noted in passing that there is actually some sharing of frequencies, which is not indicated by the aforementioned figures. Of particular interest in the matter of sharing is the suballocation in the band assigned to uhf television broadcasting for international fixed public service on a noninterference basis. The subregion set aside in this category is 716 to 890 mc. Typical use is one involving an American Telephone & Telegraph microwave relay circuit between Florida and Cuba. It would, in fact, take an entire article on this subject alone to do justice to the number of other variables present in the portion of the spectrum shown so that it is re-emphasized that the present interpretation is for gross impression only. It will be noted in Fig. 2 that Government and aeronautical services utilize approximately two thirds of the spectrum between 30 and 3,000 mc. Broadcasting might be viewed as having slightly less than 25% of the spectrum space with the remainder devoted to other categories.

The pressure for frequencies in this portion of the spectrum can be illustrated by two relatively simple examples. Fig. 3 is illustrative of this situation. In 1955, the total number of stations in the safety and special radio services category exceeded 300,000. Fig. 3 shows the growth in one category, namely public service. Although almost half, or 142,387, of the foregoing figure represents amateur stations, other major categories include the aviation services (43,855 stations), industrial services (24,854 stations), land transportation (20,002 stations) and marine services (50,714 stations). It must be recognized that according to the Federal Communications Commission (FCC) methods of maintaining records many separate station units may be counted as one station. For example, a station might include a base transmitter and many mobile unit transmitters thus increasing the aforementioned figures substantially in terms of transmitters in operation. Thus, in 1955, the FCC estimated that approximately 768,000 transmitters were authorized to operate in the safety and special radio services. Of these, about 172,000 represented fixed stations and 595,000 mobile units.

A second example of developments in this area is illustrated by the recent "Final Order of the Federal Communications Commission, *Docket No. 11253*," released September 24, 1956. This docket related to operation in the 152–162 mc band which has been shared by maritime mobile, land transportation, public safety, industrial, and domestic public users. Whereas, for many years, the channel width in this band had been 60 kc, the new order cuts this channel width to either 30 or 15 kc depending upon condition of use. In the introduction to its order, the FCC stated that the number of useable channels available to these various services for rendition of land mobile service generally is inadequate to accommodate the increasing number of licensees and potential licensees in these vital services. It indicated that solutions to this problem could be sought in various ways such as allocating additional spectrum space, increasing the use of geographical sharing or the taking advantage of developments in the state of the art which make narrower channel spacing possible. The latter action, of course, represents a recourse to the third method of providing facilities. Further than this, resort to the other methods indicated may be necessary in the future.

With reference to Government facilities in this area, Commissioner Craven of the FCC indicated in a recent talk that the Government had invested billions of dollars in a radio communications system which utilized frequencies in the region of concern. He went on to indicate that the Government's radio equipment cannot be replaced in a short space of time by the expenditures of another tax-supported program without adverse effects upon the national economy. He indicated further that the television problem is made more complex by the fact that this portion of the spectrum which is most effective for television broadcasting is of equal importance to necessary radio services such as those previously noted. He pointed out that the FCC, at present, does not view the allocation situation as entirely satisfactory and that some exising services are in urgent need of more radio spectrum space to accommodate the vastly increasing traffic load.

HISTORY OF TV ALLOCATIONS

From this present indication of the current state of the over-all allocation picture in this region, it seems appropriate to review the past in terms of the specific area of television allocations in which we are interested. In December 1945, the FCC adopted the first postwar rules and engineering standards to aid the development of commercial television service. At the end of the war, 158 applications were on file for television facilities. Some 80 of these were subsequently withdrawn with indications that applicants preferred to await color television developments or that they did not have the necessary construction funds required by the new medium. However, by mid 1946, 24 construction permits had been granted and 40 more applications were being processed. The television rules of that period specified the sharing of television Channels 1 through 5 and 7 through 13 with other radio services on a noninterference basis. A

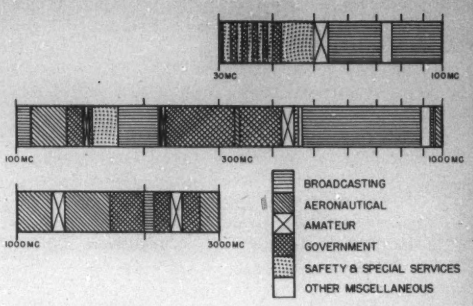

Fig. 1. Simplified frequency chart for 30–3,000 mc range showing primary service occupation.

table of channel assignments to the first 140 metropolitan districts in order of size was contained in the rules. Co-channel spacing provided was 150 miles. A maximum power of 50 kw was provided for heights up to 500 feet effective elevation above average terrain. Three classes of station were contemplated, community, metropolitan, and rural. Television Channel 1 was set aside for community type operations which were to employ powers not in excess of one kw at 500 feet. The standards of that vintage contained interference ratio criteria of 100 to 1 desired to undesired signal for the co-channel case and 2 to 1 desired to undesired signal for the adjacent channel situation. The protected contour concept was carried over from other earlier broadcast practices and the 5,000 microvolt contour became accepted for city service requirements and the 500 microvolt contour for rural service requirements. The rules stated that metropolitan type stations would not be protected beyond their 5,000 microvolt per meter contour and the standards required that interference areas within the 500 microvolt contour be shown where it prevailed.

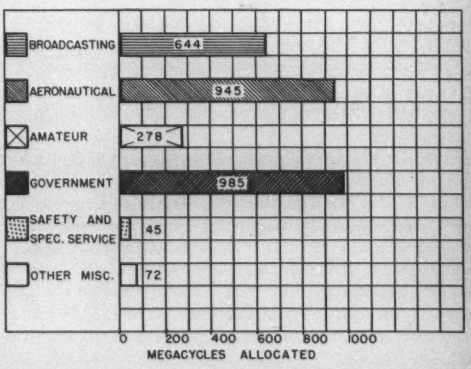

Fig. 2. Approximate total number of megacycles allocated to indicated services.

By mid 1947, six television stations had been licensed and 60 construction permits were outstanding. Nine applications were pending. The FCC continued to relax its originally imposed requirement of a minimum of 28 hours of program service per week by each station upon special request. Experience gained with frequency sharing between television and other services indicated the impracticability of continuing such sharing because of extremely vexing interference situations. Accordingly, in June 1948, the FCC adopted its proposed rule-making of August 1947 which action deleted Channel 1 (44-50 mc) from television service assigning it to the mobile and safety and special services category. As receivers were being perfected for television and the audience was mounting, mid 1948 saw seven stations licensed and 102 construction permits outstanding with 294 applications pending. With 21 additional stations in interim operation status, television broadcast service was being brought to 17 cities as compared with 8 cities the previous year.

The demand for facilities, by this time, was so much greater than the available allocated channels could be used to satisfy that 181 of the pending 294 applications had been designated for consolidated hearing. This upswing of interest caused the FCC to call an allocation hearing in June 1948 on the matter of amending the allocation table released in 1945. In its proposed rule-making the FCC issued an expanded assignment table utilizing a tabulation by state and city. No changes in the

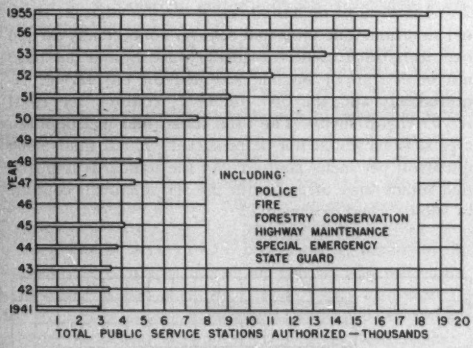

Fig. 3. Growth in one class of safety and special radio services.

previously adopted standards were suggested at that time. At the same time, engineering findings were reached by the FCC that the spectrum space below 300 mc was insufficient to make possible a truly nation-wide competitive television system and, "that some interference to television reception would result from adjacent channel operation of other services, from harmonic radiations, and noises from other electrical devices." With this in mind, a hearing was opened in September 1948 to inquire into the propagation characteristics of the band 475 to 890 mc and the state of development of receiving and transmitting equipment for this frequency region.

FREEZE ORDER OF 1948

The September 1948 conference of the FCC and industry resulted in the freeze order of September 30, 1948. This order called a halt on the processing of applications for new television stations pending the adoption of new rules and standards based on the latest available engineering information on coverage and interference. In November 1948, an engineering conference was held on this subject and the final act of this session was to refer the problem to a special ad hoc committee composed of Government and industry engineers. Their report was presented to the FCC in May 1949 and, in the same month, the FCC issued its status report looking toward the adoption of new rules and standards for the television service and the end of the freeze. By this time, 13 stations had been licensed and 104 construction permits were outstanding. In addition to the licensed stations, 58 operations were being conducted on an interim authority basis. Cities receiving service numbered 42. Of the 338 applications then pending, 237 were in hearing status.

In July 1949, the FCC announced a rule-making proceeding looking toward new television standards to avoid interference, the opening up of 42 additional channels in the uhf portion of the spectrum, and a consideration of other means of bringing television service to the public including "stratovision" and "polycasting." The former system involved broadcasting from high flying tight circling aircraft to areas of the country several hundred miles in diameter. The latter method was a proposal for supplying television service to a community or region by use of numerous low-powered synchronized television operations as opposed to delivery of service by a centrally located high-powered single station. At this same time, the FCC announced that contrary to its previous policy, it would only consider systems for color television which could operate in a six mc channel width. The necessity for the institution of this hearing in mid 1949 was emphasized by interference between television operations which had begun to show up in cases where stations came into operation with the maximum heights and powers authorized and spacing of the order of 150 miles then provided in the "Standards of Good Engineering Practice." As the instituted studies progressed, it looked as though co-channel separations would have to be increased to approximately 220 miles to retain a reasonable service area for television stations. This fact clearly reduced the number of potential assignments on the 12 available channels.

During 1950, the FCC continued its "freeze" policy concerning the construction of new television stations and consequently the number of commercial television broadcast stations on the air by mid 1951 was stabilized at 107. Television programs as a result were being provided to about 63 cities and metropolitan areas in 44 states. At this time, records indicate that 415 applications were pending with a vast majority of these being in conflict with one another. By this time, there were about 12.5 million receivers in the hands of the public.

As a result of the FCC announcement about color television aspects in 1949, three systems were proposed to the

FCC involving six mc systems. These systems involved the field sequential, the dot sequential, and line sequential systems. Preliminary findings were issued in September 1950 and the standards were amended in October of that year to provide amended standards including color components. With the ultimate finding, at that period, in favor of the field sequential system and, following some litigation in the Federal courts, commercial broadcasts using the field sequential system began in June 1951.

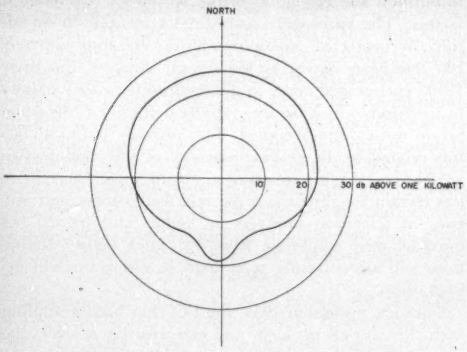

Fig. 4. Directional antenna pattern for television broadcast service.

FCC "THIRD NOTICE"

As a result of the deliberations instituted in 1948 and carried on over the period of 1949 and 1950, the FCC in March 1951 issued its "Third Notice" of further proposed rule-making looking toward engineering standards for the television service and the adoption of a nation-wide television assignment plan utilizing both the vhf and uhf portions of the frequency spectrum. At this time, they also proposed the reservation in specific communities of television channels for noncommercial educational use. These numbered about 209 assignments out of approximately 2,000 assignments listed in 1,256 cities. This third report precipitated approximately 700 written comments by the industry and 400 rebuttal comments in opposition to some of the initial 700 filings. Therefore, it was not until April of 1952 that the FCC was able to bring to a close its deliberations originated in 1948. With the adoption of its "Sixth Report and Order" in the Spring of 1952, the FCC again began to process television applications. In this process, all of the applications which had been on file were amended to conform to the new engineering standards promulgated in the "Sixth Report and Order." In the final analysis, 242 communities were recognized as warranting noncommercial educational assignments. Of these channels, 80 were for vhf and 162 for uhf. The new rules and standards divided the country into three zones setting up co-channel mileage separations varying between 170 and 220 miles for vhf operations. Slightly lower co-channel spacings were provided for uhf operation. The maximum effective radiated power on channels 2 to 6 was set at 100 kw, on channels 7 to 13 at 316 kw and on uhf channels 14 to 83 at 1,000 kw.

By the middle of 1953, the FCC had authorized a total of nearly 400 television stations in the first year following the lifting of the freeze. This was exclusive of the original nucleus of 107 stations which had proved to be highly profitable in most cases over the period of artificial restraint in expansion of the television industry. By mid 1954, with the granting of another 100 authorizations during the second year period following the lifting of the freeze, authorizations to a total of 603 licensees or potential licensees had been granted. Of this number, 573 were for commercial operation. Stations numbering 402 were either on the air or authorized to go on the air. The total grants represented 340 vhf and 233 uhf stations of which 265 vhf and 137 uhf stations had operating authorizations. These were bringing service to a vast audience over most of the United States as well as Alaska, Hawaii, and Puerto Rico.

"SIMULTANEOUS" COLOR SYSTEM APPROVED

In another respect, 1953 was a historic year for television, aside from the allocation situation: on December 17, 1953, the FCC adopted new color transmission standards that had been developed and advocated by the industry through the postwar National Television System Committee. The new color standards issued by the FCC were based upon a "simultaneous" system replacing the "field sequential" system previously approved in 1950. The simultaneous system had the overwhelming advantage of being compatible with the existing black and white system. Reduced to simplest terms, this meant that owners of monochrome sets would receive a black and white picture of a show being broadcast in compatible color. Although not strictly of allocations import, the considerations involving color were extremely important from two standpoints. First, here was a new technological development which occupied much of the FCC's effort and in some respects affected the time schedule during a majority

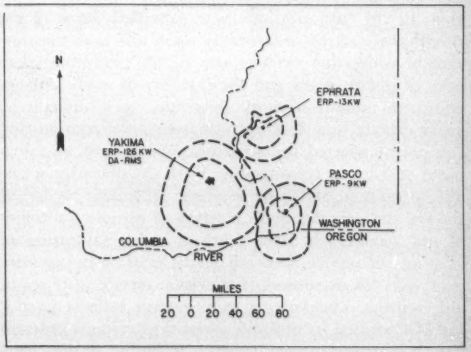

Fig. 5. Typical television satellite situation.

of the 10-year period under discussion. Second, the situation is important as an example of nonexploitation by the industry of a facet of the television system which the FCC in 1950 found to be technically superior to other systems then proposed. It is not the purpose of this article to adopt either of the major viewpoints of the early 1950's but simply to point out that the industry was criticized for not pursuing a system which had been authorized by the FCC as opposed to engaging in a lengthy and more extensive developmental effort to work out an alternative and superior system. However, this delayed placing color television receiving sets in the hands of the public only by four or five years.

UHF PROBLEMS

ALTHOUGH FOR A TIME, in this postfreeze period, two uhf authorizations were issued for every three vhf authorizations, within two years following the lifting of the freeze, over 70 uhf authorizations had been cancelled. Six of these cancellations involved stations which had been authorized to operate and were actually in interim operation on special temporary authority. During this same period, 12 vhf authorizations were cancelled. Some of the conditions reacting unfavorably upon uhf were the slow rate of converting existing sets to uhf reception, slow sales of uhf receivers and the inability of many uhf operators to obtain network programs. It is difficult to assess exactly how lack of high-power uhf transmitting equipment affected this situation, but it must be recognized that it was considerable. With the difficulty of the uhf operator in obtaining coverage equivalent to that of the vhf stations, the chain reaction of a limited number of uhf receivers in some markets and a saturation of existing vhf service rendered many areas of the country poor risks for expansion of television service in terms of uhf facilities. Endeavoring to encourage interest in uhf, the FCC revised its multiple ownership rules in order to permit licensees to operate seven television stations provided that at least two of these were uhf. This, of course, was a departure from the older limitation of five television outlets per licensee. Directional antenna patterns, such as that shown in Fig. 4, were also authorized to provide tailoring of the signal distribution to the area of primary concern.

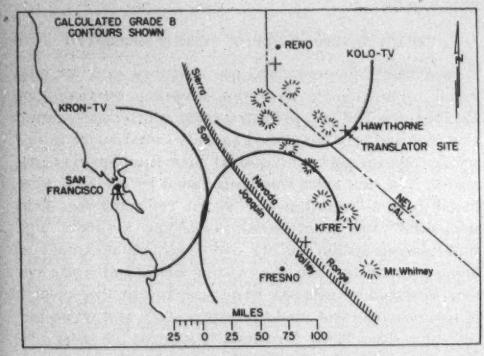

Fig. 6. Typical television translator situation.

It is fair to say that the troubles which have beset the television industry in the past two years are, in part, due to business and economic factors as well as technological factors. The successful commercial operation in an artificially protected monopoly enjoyed by approximately 100 television operators for several years in the early 1950's encouraged many to plunge into television activity in situations which became rapidly marginal as the number of outlets mushroomed. The primary technical factors related to the general inability of uhf operators to achieve comparable coverage to vhf in areas where there was terrain roughness and the relatively poorer performance of television receivers as higher and higher frequencies were employed. Receiver "noise figure" limitations still are currently prominent in uhf versus vhf deliberations.

Since the middle of 1954, the FCC has been grappling with the over-all problem and endeavoring to assist the growth of uhf. Among the steps considered was a revision of the chain broadcasting rules in the matter of territorial exclusivity to prevent an existing station from contracting with a network to keep a station in an adjoining community from obtaining that network's programs. Another involved the allowance of television stations to operate their own intercity relay systems despite the availability of common carrier relay facilities. The FCC has also authorized uhf and vhf "satellite" stations operating on channels provided in the table of assignments but without independent programming of their own. In this way, the broadcaster has been enabled in some cases to extend his television service area. At present, proceedings are still under way in *Docket No. 11331* looking toward the authorization of co-channel "booster" stations for uhf operators which would enable them to fill service holes within their existing contours. One example of the application of satellite operations is shown in Fig. 5. This may be viewed as a mother station feeding two satellites with all employing common programming, thereby securing a service area larger than could be provided from a single source. In some respects, this may be viewed as a slightly different variation on the "polycasting" theme.

Corollary to the allocation problem has been the growth of systems involving wired distribution of television service. Nearly 400 community antenna television systems are in operation today. These systems pick up existing television programs from television broadcast operations using antennas advantageously located on mountain tops or other natural elevations. Signals from these master receiving locations are then distributed by cable to individual homes in communities which, because of terrain difficulties, have not been able to receive television programs directly. In some instances, the desire of the community antenna system operator to avoid distribution costs has led to the employment of low-power rebroadcast units which have been condemned as illegal by the

FCC. However, in answer to this problem, the FCC in July 1956 issued rules to govern what has been termed "television translator" service by designating uhf channels 70 to 83 for use by this service. It is contemplated that FCC type approved 10-watt transmitters will be used. Fig. 6 shows a typical situation which has been authorized to serve the community in the vicinity of Hawthorne, Nev. This illustration shows the theoretical service contours from San Francisco and Fresno, Calif. and Reno, Nev. Their inability to reach into Hawthorne is caused by the extremely rugged terrain of the Sierra Nevada range. The translator station located on the mountaintop nearest Hawthorne will employ a highly directional antenna to beam an effective radiated power approximating 100 watts into the valley. This trend to the lower power operations has also been carried into the general rules governing the television broadcast service and the old minimum effective radiated power provisions have given way to provisions that require only the observance of certain minimum signal requirements.

On August 15, 1956, the FCC revised the maximum power allowed uhf operators upward from 1,000 kw to 5,000 kw. This brings the authorized maximum power into a region of authorization which propagation data taken as early as 1948 in a series of uhf tests indicated as necessary to compete satisfactorily with vhf operations on a coverage basis. Several uhf operators are now employing effective radiated powers of 1,000 kw and recently one of them increased effective radiated power under the new rule to 1,500 kw. Extensive propagation tests are still going forward today looking toward the ability to define the gap between uhf and vhf television propagation factors.

FUTURE OF TV BROADCASTING

MEANWHILE, AS THE EFFORT on the engineering front goes forward, the FCC again is considering revisions in its assignment table in an endeavor to aid the growth of the television broadcast service. Prominent in these considerations are a number of "deintermixture" questions. In certain areas, the FCC has issued notices of suggested revision looking toward maintaining or reverting certain areas to the exclusive use of uhf facilities. The latest deintermixture proposals were issued in connection with a final report in one of the general rule-making proceedings which anticipates a continuing allocations exploration in this entire area. The latest interim report of the Senate Committee on Interstate and Foreign Commerce commended the latest FCC actions in this regard. They note that encouraging experiments have been conducted with uhf powers of the order of 4,500 kw and even higher power. More recently, there have been suggestions that all television broadcasting should be moved to the uhf portion of the spectrum.

Even as there were corollary considerations such as color television running through the first 10-year period which has been discussed, there are similar allied considerations of which the FCC is cognizant today. During the past five years, the FCC has allowed experimentation with several systems of subscription television. This contemplates the distribution of a program to those receiver owners who would through some means or other pay for it. In a sense, there is a similarity here with the community antenna television system situation which represents another problem for the FCC paralleling the allocation situation. In this instance, people pay not on a per program basis, which subscription television would contemplate, but would pay a fixed installation charge for the service itself and then pay a continuing monthly service charge for programs distributed from a master redistribution source. The total number of viewers in this category has been approximated at 1 million.

The most recent parallel to 1948 activities has been occasioned by the request of the chairman of the FCC made to the Association of Federal Communications Consulting Engineers (AFCCE) for review of the reasonableness of the engineering methods proposed to serve as a technical basis for estimating interference-free coverage of vhf and uhf stations. The report of this group which has now been made to the chairman of the FCC emphasizes, in the main, that practice has shown that departures of measured fields from the average empirical curves are real as they relate to television service fields from broadcast stations and more particularly are definitely a function of the types of terrain over which the signal travels. The AFCCE representatives indicate that primary weight should be given to measurement data to avoid the danger of oversimplification which lurks in endeavoring to judge individual cases on the basis of an average curve. Here, too, is evidence of a trend which has occurred before in the 35-year history of broadcast activities. Inasmuch as originally the development of systems has been based on average conditions, sooner or later regulations and standards have recognized the validity of systematic determination of propagation factors and applied this knowledge to the further development of the service.

There may be a return to the protected contour concept of 1945 for the television broadcast service as opposed to the strict assignment of stations within a stringent mileage separation criteria. Already new regulations, recently put into effect, allow channel assignments on a transmitter site to transmitter site basis rather than the city to city basis utilized until about a year ago. Current standards also provide for offset carrier operation of television transmitters which make a 28 db co-channel interference ratio practical for existing considerations as contrasted to the 100 to 1 (40 db) ratio prevailing in 1945. New developments recently announced, utilizing high stability crystal control of both television carrier and line rate frequencies, place a 20 db ratio within the realm of possibility. The reduction of susceptibility to interference in the television service by a factor of almost 10 forecasts the possibilities of either wider effective service ranges by existing stations or the ability to reduce station separation considerably. The utilization of some of these new tolerances coupled with directional antenna techniques such as are common in the standard broadcast field, may be the next logical step in the television broadcast service.

Future Military Aircraft Electrical Systems

E. F. FEDERMANN T. M. CORRY ASSOCIATE MEMBER W. C. MORELAND

The nature of feasible electrical systems to meet the needs of future aircraft is discussed. This involves an indication of the better solutions to the electrical system problems and the means of obtaining these solutions.

FOR THE PURPOSE of this presentation, an electrical system is defined as the integrated combination of the generation, conversion, distribution, and utilization equipment.

The topics discussed in this article have been covered in considerable detail in a report which was the culmination of a year's study on a contract with the Air Research and Development Command (ARDC). The group selected to make this study was comprised of people who had considerable experience in making objective studies of this sort. Therefore, it is hoped there are no prejudiced or preconceived notions, and it is felt that the conclusions based on this analysis are unbiased and factual.

There are various ways in which a problem of this type can be attacked. A logical order and singleness of purpose must be maintained whatever method is chosen; the evaluation on a haphazard basis of permutations and combinations of existing and contemplated components must be avoided. Therefore, the method of attacking the problem should not consist of individual evaluations of segments of the electrical system, with each segment being considered for the total range of aircraft functions. For example, it would seem unprofitable to analyze generation and distribution systems independently for aircraft ranging from small stripped-down fighters to heavy intercontinental bombers.

A much more fruitful and logical approach is the selection of a typical intermediate type of airplane and the use of this aircraft for the evaluation of the entire electrical system. This was the approach used during the study. The results of this evaluation were then used to extrapolate to other aircraft families so that variations in performance, speed, function, and ambient conditions could be accounted for. In accord with this approach, a hypothetical 1965 aircraft was defined. This jet powered plane is a piloted medium bomber which would be at the preproduction stage 10 years from now and which is expected to be representative of this type of aircraft. Similar assumptions were made concerning other aircraft types so that extrapolations could be made. It is possible that the requirements of unusual or research type aircraft which are outside the scope of the study will be radically different from the conventional type considered here and will have quite different requirements for their electrical systems. For the intermediate bomber selected, the loads were predicted and divided into there classes: Class I—electronic, Class II—motors, and Class III—heating and miscellaneous.

After the loads were selected, means for supplying electrical power to the equipment were analyzed; this included generation, distribution, and conversion. In all cases, the load and supply were considered as interrelated inasmuch as preferences of specific equipment must be balanced against the best over-all result. Also, consideration must be given to cooling that portion of the equipment which cannot operate in the environment because there is a definite relationship between the cost of the electrical system and the type and amount of cooling required. In evaluating the electrical system, numerous parameters are of importance. These include weight, reliability, maintainability, availability, vulnerability, volume, and cost. For quantitative evaluation, weight was selected as the criterion although, where pertinent, due consideration was given to the other factors.

In the electrical system evaluation, it is imperative that the many smaller problems should not be allowed to obscure the larger issues. Indeed, continual discrimination must be exercised to avoid being overwhelmed by the immensity of a problem which involves virtually all phases of engineering and physics; otherwise, one is led into a maze of detailed problems at the expense of the achievement of the direct objective. Therefore, the study attempted to (1) predict the nature of future aircraft, in order to evaluate electrical system needs; (2) analyze objectively the electrical system, as a whole, to determine and evaluate its problems in relation to the general aircraft problems; (3) place the various elements of the electrical system in their proper perspective; and (4) determine those material components and techniques which will be needed in future systems. It did not attempt to (1) design or propose the design of a specific aircraft and its electrical system; (2) design, propose, or recommend specific equipment or devices; or (3) compile data to be used as a yardstick to compare specific pieces of equipment or portions of the electrical system. Inasmuch as the findings of this study are contained in a 300-page report, this article will deal only with some of the more provocative items. Specifically, there are three of major importance. These relate to the selection of a supply system, the penalty to be assigned to equipment cooling, and the means of reducing electrical system weight.

A special article recommended by the Committee on Air Transportation.

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FUTURE ELECTRICAL PROBLEMS

BEFORE GOING INTO A DISCUSSION of these topics, it will be well to specify briefly the anticipated electrical problems of future aircraft. The difficulties at the present time have been caused primarily by the growing complexity of the functions performed by the electronic equipment. This results in a large weight increase and a schedule problem—the airplane usually is completed before the specified electronic equipment is available. In addition, installation of this equipment is becoming more difficult, and its maintenance is becoming more complex. The control surface and fuel pump power requirements are also growing rapidly. When these requirements are combined with the fact that the airplane gross weight increase per pound of equipment added is becoming more important, it becomes evident that even for present-day aircraft many problems exist. Although these problems will be magnified in the future, they probably will be of the same nature. The factors adding to their severity in future aircraft will be the further increased power requirements and number of functions, the extremely high temperature environment, the increased accuracy requirements, and the greater airplane weight increase per pound of equipment carried. In fact, with the advent of operational aircraft capable of sustained supersonic speed, it is likely that the combination of high temperature and increased number of functions will make mandatory drastic changes in present electrical supply and utilization equipment and techniques, if it is to be possible to construct aircraft of reasonable size to carry the required equipment. Thus, it becomes evident that new components and techniques will be necessary if the goal set for future aircraft is to be realized. It is essential that these components and techniques are not merely substituted for present devices; their application to future aircraft must be considered with a new approach to the electrical system problem.

The need for electrical energy on an airplane can be separated into two major divisions. A group of functions exist that under present and predicted knowledge must be done electrically. These include most of the complex bombing, fire control, navigation, automatic flight, and radar equipments. The second group can use electrical energy advantageously at the present time, but other means may be used in the future if the benefit of electrical operation diminishes or if new and improved nonelectrical equipment is developed—items in this group include fuel pumps and control surface actuators. A separate treatment of these energy requirements will facilitate system analysis. In the first case, the electrical system problems must be solved; in the second, alternate nonelectrical solutions enter into the analyses. Although there always will exist a minimum requirement for electrical energy on future aircraft to supply functions of the first category, there exists the problem of being able to supply and utilize this energy at a reasonable cost (weight penalty). On the basis of considerable present-day data and extrapolation into future techniques and systems, the weight of the electrical system and its associated cooling for the future medium-bomber has been determined. Table I is based upon the use of hydraulic control surface actuation and the most advanced present-day techniques in electronic circuitry. The power supply weight is for the amount of power required to supply continuously the entire connected load; the reserve power problem will not be treated in this article. Distribution from the main bus is included in the load weight figures.

Table I

	Kw	Weight (pounds)	Per Cent
Class I Load	55	6,515	75
Class II Load } Class III Load }	45	715	8
Power Supplies (including Conversion)		850	10
Equipment Cooling		660	7
	100	8,740	100

An estimate of the weight breakdown for an electrical system utilizing electrical rather than hydraulic actuation is given in Table II to show that the basic analysis is not altered appreciably for this case.

Table II

	Weight (pounds)	Per Cent
Class I Load	6,515	65
Class II Load } Class III Load }	1,115	11
Power	1,650	16
Equipment Cooling	660	7
	9,940	100

The data in these two tables will be used as the discussion progresses.

SELECTION OF A SUPPLY SYSTEM

THE SELECTION of the complete electrical system is based upon the least over-all penalty; in analyzing the supply system requirements this fact must be kept in mind. It is present on the airplane for the sole purpose of supplying the utilization equipment; it does not exist for itself alone. Therefore, evaluation of a supply system without consideration of the load is pointless. For example, there is no gain in saving 100 pounds in the supply system at the expense of a 1,000-pound load weight increase. The converse, of course, is also true. These statements may appear innocuous, but it is surprising the number of supply system evaluations made in the past which gave insufficient consideration to the load requirements. As a result, there are several competitive supply systems of almost equal merit and it readily can be understood that there has been considerable argument in the industry as to which is the better system. However, when the load requirements are considered, the problem then essentially reduces to determining which of these systems can best supply the load. On this basis, the selection is narrowed considerably. In fact, the present acceptable 400-cycle, 3-phase, 115-200-volt system with somewhat closer tolerances shows up quite favorably when the load is considered, and it appears that the time spent in attempting to devise different supply systems could more profitably be spent in the improvement of an acceptable system. For example, some increase in the supply system weight could well result in an over-all

electrical system weight reduction. This in no way implies that the present supply systems are not very good; in fact, they are. But it does imply that with a shift in emphasis, they could help to reduce problems not directly associated with the supply system. One method of reducing the Class I load weight considerably is the use of what will be termed an "Integrated System." This system would include, as part of the central power supply, the important d-c voltages required for the electronic equipment. For example, if the electronic equipment can be designed to utilize a minimum number of d-c voltages, a single supply could be used to provide this power. It has been estimated for the specific future aircraft under discussion that 20 kw of the total 55-kw Class I load will be supplied in this manner. The remaining 35-kw load is comprised of high voltage radar plate supplies, filaments, magnetic amplifiers, synchronous mechanisms, etc., and will be supplied by the basic power source directly. The weight savings that can be effected by the use of an integrated system will be covered later in this paper.

It is not to be implied in the discussion of the aforementioned specific system that no parameter of this system could be changed to advantage. For instance, on some types of aircraft with extremely large loads and long lines some advantage might be gained by going to higher voltage. In other situations, an increase in frequency might result in a weight reduction for some apparatus. It appears, however, that the over-all gain will be relatively small. A theoretical analysis indicated a maximum system gain of 5 pounds per kw for a frequency increase to 1,600 cycles per second; this estimate is based on the most optimistic assumptions and an extensive development program. Finally, it is not the purpose of this article to select the best supply system. Rather, it is intended to show that the selection of a specific system should be based on the load requirements and that effort spent devising changes of basic systems is not as useful as effort spent in improving a particular adequate system.

THE DETERMINATION OF A COOLING PENALTY

IN ORDER TO APPRECIATE the cooling penalty evaluation it is necessary to consider the reasons for the inclusion of this parameter in an electrical system analysis. The primary factor, of course, is the very high ambient temperature that will be encountered on future aircraft. However, as far as the electrical system is concerned, this is of importance only because the electrical equipment is limited in its temperature tolerance and because it generates heat. Finally, although there is almost invariably a relationship between these factors and the weight and design of the electrical equipment, a quantitative cooling penalty must be available for the electrical system evaluation.

It should be kept in mind that this penalty is all that is required; a detailed study of optimum cooling systems for the entire aircraft function is not needed here. In selecting the penalty, care must be taken that the proper value is assessed to the electrical equipment. On the type of aircraft being considered it is necessary that some measure of cooling be provided for the crew, and it is important that the electrical cooling penalty be assessed after the basic penalty for the crew has been accounted for. This means that it is quite possible, because of the low temperature exit air from the crew compartment in certain systems, that some of the electrical equipment could be cooled with little additional penalty. However, in the past, the electrical equipment has essentially been assigned a penalty for air conditioning rather than cooling. Because it is very difficult to evaluate the portion of the penalty to be born by the electrical equipment in these cases, a somewhat different approach has been taken. This approach consists of determining the cooling penalty for electrical equipment alone on the basis of the best means of accomplishing this purpose. If this figure is not inordinately high, the complex compartment plus equipment problem need not be considered inasmuch as the penalty to the electrical equipment should not exceed that which would apply if it were cooled alone. In other words, the penalty so determined is a maximum penalty and the use of this figure in the electrical system evaluation is conservative.

For the aircraft being considered, the maximum penalty has been evaluated at 12 pounds per kw. This means that in the case of electronic equipment it may cost up to 12 pounds to remove each kilowatt of heat generated on a representative future medium bomber. If the ambient temperature can be tolerated by the equipment, the total penalty is simply the product of the kilowatt dissipation of the equipment and the cooling penalty; if the equipment cannot withstand the ambient, there will be an additional cost for the removal of heat that flows into the compartment. It so happens that on the aircraft in question, the ambient temperature is predicted to be in the region of 400 F and the predicted temperature tolerance of future electronic components matches this figure. For the cooling system chosen on this aircraft, the cooling penalty varies only moderately with the ambient temperature. However, in extrapolating to other aircraft, the heat flow problem may also be of importance. For example, on a stripped fighter, the uncooled compartments may reach temperatures in excess of 600 F with a consequent increase in cooling penalty. In addition, the time duration of high speed flight also affects the penalty and for very long periods of high speed flight the 12 pounds per kw will have to be increased somewhat.

It is evident that the temperature tolerance of the electrical equipment is of great importance in the cooling problem. If the electronic equipment can be designed so that its temperature tolerance meets the ambient, there will be no additional cost for the removal of heat flow into the compartment. There may also be additional gains dependent upon which cooling system is used. However, further increases in the temperature tolerance will, in general, not be particularly advantageous unless the equipment can be designed to require no cooling at all. It has been predicted that the Class II and III loads will be composed chiefly of components that can withstand the environment without supplementary cooling. It is most important that this goal be met because the cooling

of this equipment can result in severe penalties. Thus, the development of equipment of this type with allowable hotspot temperatures considerably in excess of the ambients mentioned would be very desirable. Finally, generators are not expected to require cooling from the main cooling system although engine oil or ram air cooling will probably be needed.

THE PROBLEM OF REDUCING SYSTEM WEIGHT

As has been mentioned, there are many items other than weight involved in an electrical system evaluation. It will be assumed in this analysis that these qualities do not change as the various means of weight reduction are applied. In particular, it is felt that reliability should not be sacrificed for a reduction in weight.

It is apparent from the equipment weight breakdown that the most promising portion of the load for weight reduction is the Class I equipment; therefore, it will be advantageous to examine in some detail the reasons for its large weight. Various electronic equipments have been investigated in considerable detail and, on the basis of these data, Table III gives estimates made of the weight breakdown.

Table III

	Pounds (per kw)	Per Cent
Chassis and Hardware	31	23
Transformers, Chokes, etc.	20	15
Electronic Components	37	28
Internal Wiring	5	4
Connecting Cable and Connectors	40	30
	133	100

Although these figures were obtained for a specific system, they were checked against numerous other systems of various types and are considered to be representative of the bulk of Class I apparatus. Table IV shows another type of breakdown that will be of interest and indicates the cost of supplying the special d-c power required for electronic equipment for the modern nonintegrated system.

Table IV

	Weight (pounds)
D-C Power Supplies	
Low Voltage 56 pounds	
High Voltage 22 pounds	
Special 15 pounds	93
Filament Voltage Regulator	16
Utilization Equipment	319
Connecting Cable	183
	611

The power requirement of this system after low voltage conversion is 4,130 watts and on this basis, the system weight is 148 pounds per kw. The cost of the utilization equipment is 77 pounds per kw and the cable cost is 44 pounds per kw. In terms of power handling, the power supply weight is approximately 73 pounds per kw average, 130 pounds per kw for regulated d-c, and 35 pounds per kw for unregulated d-c. For the system, the cost of conversion is 109 pounds divided by 4,130 watts or 27 pounds per kw.

There are several promising ways of reducing the weight penalty of this equipment. The first of these lies in the use of the integrated system approach which has already been described. The details of its accomplishment are covered in the ARDC report; this analysis will be concerned only with the anticipated weight reduction that will result from its application. On the basis of data on the cost of d-c power, the estimated cost of integrated system power, and the estimated reduction of cable and utilization equipment weight which will result from the use of the integrated system, it is estimated that a saving of approximately 54 pounds per kw can be achieved in the previously described system. This estimate has been practically justified by actual systems now in the development stage.

Now that the 148 pounds per kw penalty has been reduced to 94 pounds per kw, where can further weight reductions be accomplished? It would appear that effort should be spent in determining the mechanical strength requirements of the chassis and mounting, and that the least costly means of attaining the needed strength be investigated. Reference to the weight breakdown indicates that the chassis and hardware cost is now 31 pounds per kw.

There now remains only the actual electronic equipment itself for the further reduction of weight. Inasmuch as the data given is for the best present-day techniques, it is to be expected that in the future numerous new developments will be available for electrical system improvement. In applying these to the Class I equipment, it should be kept in mind that the pounds per kw penalty for the utilization equipment must be judged in a different light than the pounds per kw penalty for the power supply equipment. In the case of the utilization equipment, improvements can result in changes in both the weight of the device and in the power consumed. This is not the case for the supply, where power is required, and the obvious objective is the reduction of the weight of equipment needed to furnish the required power—provided no deleterious effects result from the reduction of weight. Since a choice exists for the utilization equipment in that weight, power consumption, or both may be changed in either direction at various rates, the designer in attacking this problem should have a guide for the best procedure for the maximum function weight reduction. If, for the performance of a given electronic function, $F_w = W + cP$, where

F_w = total weight cost of the function
W = equipment weight
P = power required for the function
c = pounds per kw cost for power and cooling

the total differential of F_w is

$$dF_w = \left(\frac{\delta F_w}{\delta W}\right) dW + \left(\frac{\delta F_w}{\delta P}\right) dP$$

and

$$\frac{dF_w}{F_w} = \frac{dW}{W + cP} + \frac{c\,dP}{W + cP}$$

If a is defined as W/P or the pounds per kw equipment penalty,

$$\frac{dF_w}{F_w} = \frac{dW}{W}\left(\frac{a}{a+c}\right) + \frac{dP}{P}\left(\frac{c}{a+c}\right)$$

For the aircraft being considered,

$$\frac{a}{a+c} = 0.85 \text{ and } \frac{c}{a+c} = 0.15$$

therefore,

$$\frac{dF_w}{F} = 0.85\ \frac{dW}{W} + 0.15\ \frac{dP}{P}$$

This equation, in words, states that the percentage change in function weight is equal to the percentage change in equipment weight multiplied by 0.85 plus the percentage change in power times 0.15. This will serve as a guide in the approach to the question of where emphasis should be placed when both weight and power consumption can be reduced in a given piece of utilization equipment. For example, in transistorizing a specific piece of equipment, unless power reduction can be accomplished at about six times the percentage rate of weight reduction the concentration should be on the reduction of weight in the equipment. It should be noted in the foregoing equation that a depends upon both the weight of the equipment and the power consumed, and that as the equipment is improved, the factors $\left(\frac{a}{a+c}\right)$ and $\left(\frac{c}{a+c}\right)$ change. The value of a is based on the average figure of the best present-day equipment; as the weight is reduced by the methods suggested in this paper, it will also be reduced. Although it seems logical to consider improvements in percentage terms, the absolute values will also be useful. For present-day Class I equipment a reduction of one kw is equivalent to a 22 pound equipment weight reduction. It is interesting to note that the complete elimination of the power requirement for the 55-kw predicted electronic load would result in a 1,200 pound reduction in the electrical system weight, and that this is equivalent to only about a 20% Class I equipment weight reduction.

In attempting to reduce the weight of the actual electronic equipment, two broad approaches are available—the system approach and the component approach. The system approach involves the reduction of weight in a particular function by a careful design of the over-all system using the latest components and techniques. The component approach can be described as the reduction of weight by the application of new components to a system as it is or the varying of parameters, such as frequency, in an existing system. It is felt that the system approach has the greater promise at the present time. This does not mean that continual component improvements of an incremental or novel nature are not necessary or desirable. Rather, it is anticipated that the use of the system approach will result in the most effective use of the latest developments and, at the same time, effect improvement in design techniques and a reduction of redundancy. It is evident that the system and component approaches are related, to some extent. In using the system approach, it is inevitable that the need for specific new components will be discovered and that many component problems that seem important today will be eliminated. The effect of variation of parameters may also be altered or eliminated. The preference for the system approach has already been substantiated by the gains achieved by the use of integrated systems and the redesign of existing systems. This is only the beginning of the exploration of this approach; the effective use of the latest components and packaging techniques should result in a substantial further improvement in both weight and reliability. Also, emphasis on the system approach will undoubtedly eliminate many present-day component and parameter problems. It seems sensible, therefore, to place the greater emphasis on the system approach. After it has been exploited fully, the component approach can be reconsidered.

Some specific applications of the foregoing philosophy can be made in the reduction of electronic utilization equipment weight. The application of transistors and new packaging techniques to entire electronic functional systems should be attempted. This could proceed by either a socket-by-socket replacement of vacuum tubes by transistors, or by a re-examination of the entire system function for the purpose of best using transistors and combining their use with the latest packaging techniques. It is almost certain that the latter procedure will result in the greater weight reduction. In approaching the system problem, use can be made of available data which indicate where the greatest emphasis should be; i.e., the formula relating weight reduction to power reduction. A typical component approach would be the use of higher frequency for the Class I load. It has been mentioned that the maximum system weight reduction to be expected for an increase to 1,600 cps is 5 pounds per kw. The use of this higher frequency would require a sizable development program for both the utilization and supply apparatus before even the 5 pounds per kw gain could be realized. On the other hand, the benefit of higher frequency may diminish in future systems using new components.

One additional point that should not be overlooked is the possibility of improving the quality of the power sources to effect reduction of load weight. The ratio of the weight of the Class I load to the supply equipment is, at present, so great that a small percentage decrease in load weight would compensate for an appreciable added supply weight.

CONCLUSIONS

To SUMMARIZE BRIEFLY the conclusions based on this analysis, the following considerations appear to be of major importance to the designers of future aircraft electrical systems:

(1) The selection of the electric power supply system will depend primarily upon its effect on the electrical

load weight and performance. The actual weights of several competitive supply systems are sufficiently close so that, even if they had equal effect on the load, factors other than weight would determine the selection of the best system. The more or less standard 400 cps, constant frequency, 3-phase, 115-200 volt system with a 1% accuracy will be satisfactory for all but a minute portion of the load for the type of aircraft considered in this analysis. Minor variations, such as voltage or frequency, may be considered, although at this time it appears to be more advantageous to explore the other possibilities of weight reduction first.

(2) A realistic cooling penalty for the type of aircraft described is 12 pounds per kw. This is based on a temperature tolerance of 400 F for the electronic components and the anticipation that the Class II and III equipment will be able to operate in the high temperature environment without supplementary cooling. On the basis of extensive present-day data, these goals seem quite reasonable. If they are not achieved, the cost of cooling may be much greater.

(3) There appears to be great promise for the reduction of Class I (electronic) load weight. The suggested means of accomplishing this reduction lies in the following approach:

The use of an Integrated System to supply the Class I load.

The reduction of interconnecting cable between the individual units which make up an electronic system. This will be facilitated by the use of an integrated system.

Reduction in the weight of chassis and mechanical supports might be effected by studying the strength requirements and the means of obtaining the required strength with minimum weight.

The weight of the components comprising the actual electronic functions may be reduced by the system approach as described in this report. In considering the problem of equipment weight reduction, the designer should keep in mind the equation relating function weight to equipment weight and power reduction.

Although the conclusions are, to a certain extent, based on a hypothetical medium bomber of the future, they can be extended to other types of aircraft with only minor modification. This is particularly true for the interceptor type fighter and the conventional heavy bomber.

TV on a High Plane

High atop a barren mountain in New Hampshire, anchored deeply to the summit, stands a 30 by 75 foot building and an 87 foot tower. Lashed constantly by the "worst weather on earth," these are the transmitting facilities of WMTW, Poland Spring, Maine, telecasting on Channel 8.

Back in 1953, when plans were being made to build the transmitter, there were some who thought that Mt. Washington, with its hurricane-like winds was not the place to put anything, much less delicate television transmitting equipment. But, on August 31, 1954, WMTW broadcast its first signal, and now almost three years later, wind, snow, and ice have not stopped the operation.

The studios of WMTW are located in Poland Sring, Maine, 85 road miles away from the transmitter. A Raytheon *MTR-50* microwave relay beams the signal to the top of the mountain over the longest microwave relay on record, 46.2 air miles. In as much as power lines cannot be run in from the outside (wind and snow slide danger make it impractical), three Caterpillar diesel electric sets, two *D375*'s and a *D8800*, with a total capacity of 500 kw, provide power for the operation. An RCA *TT50AL* transmitter delivers the boosted signal to a special Alford antenna. This antenna is unique in that it must be kept free of ice in an area where ice and frost form at the rate of six inches per hour. Inside the horseshoe elements is a heating system which requires as much power as the entire transmitting station. De-icing equipment, for the Alford antenna requires up to 100 kw from the electric set during maximum icing conditions.

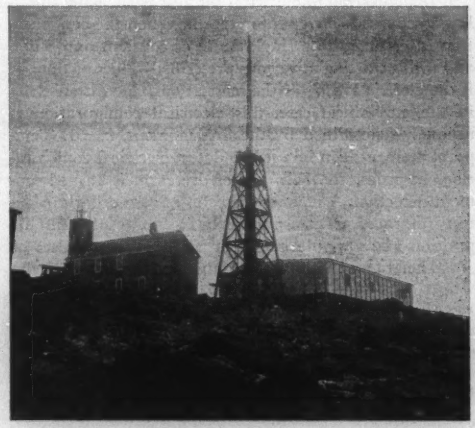

Fig. 1.—View of Transmitting Station atop Mt. Washington.

WMTW is owned and operated by Mt. Washington TV, Inc., with an authorized visual power of 105 kw and 52.5 kw aural. The antenna is 3,840 feet above average terrain and 6,375 feet above sea level.

Moment Detection and Coding

J. J. SLADE, JR. S. FICH L. F. NANNI D. A. MOLONY

MEMBER AIEE

THE APPLICATION of moments to determine the center of gravity, moment of inertia, and other properties of mechanical systems is well known. These computations involve the product of integral powers of the distance measured from some reference point and area, volume, mass, etc. Moments can also be used to determine a configuration of electric signals consisting of one or more d-c pulses restricted to exist at specified periods of time measured from a reference of zero time. In the electrical case, the moments consist of the products of voltage or current and integral powers of the time. For this reason, they may be called temporal moments. The temporal moment of order k of a function of time $f(t)$, calculated in the interval from $t = 0$, *to* $t = T$, is defined as follows:

$$m_k(T,f) = \int_0^T t^k f(t)dt \qquad (1)$$

When $k = 0$,

$$m_0(T,f) = \int_0^T f(t)dt \qquad (2)$$

where m_0 (T, f) is the area or content under the curve of $f(t)$ from $t = 0$ to $t = T$.

A configuration of electrical pulses can be made to follow a code and convey information. When the configuration is restricted to a single pulse of constant amplitude and width existing at various prescribed values of time, it is the electric analog of the mass at variable distance. As in the mechanical case, this electrical configuration is uniquely determined by the first moment, $k = 1$. Temporal moments can be used to detect electrical configurations or codes, and this type of detection is termed moment detection. A moment detector of zero order can detect information transmitted by a pulse of constant position and variable height or width. When pulses of equal height and width but variable position are used, the zero-order moment detector fails when the period of integration extends over several allowed pulse positions, and the first moment is required for detection. This condition is illustrated in Fig. 1.

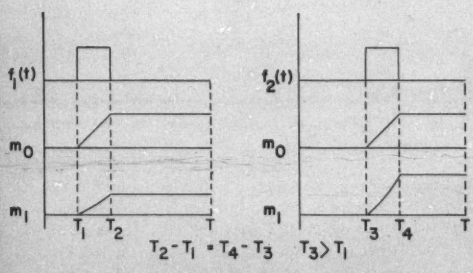

Fig. 1. Moments of pulses of constant area and variable position.

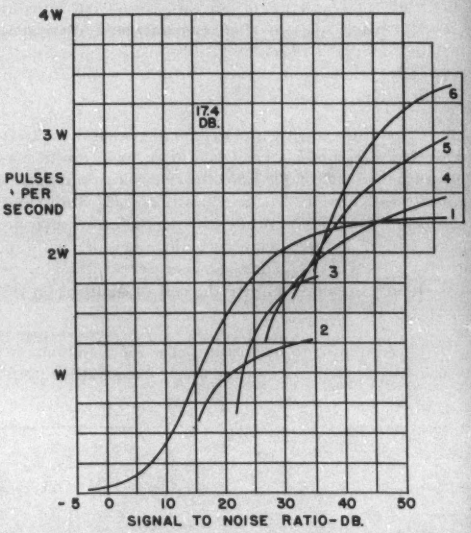

Fig. 2. Transmission rates using 1 to 6 pulses ($\alpha = 10^{-4}$).

In amplitude detection in the presence of noise, the required signal to noise ratio is a function only of the probability of error; in moment detection the signal to noise ratio is a function both of the probability of error (α) and the speed of signaling (pulses per second). The inherent flexibility of moment detection results from the integration technique, and is illustrated in Fig. 2. In amplitude detection, a signal-to-noise ratio of 17.4 db is required to transmit $2W$ pulses per second with a probability of error equal to 10^{-4}, where W is the bandwidth of the system. With respect to these values of signal-to-noise ratio and speed of signaling, it appears that moment detection holds most promise in cases of low signal-to-noise ratio where low speeds of signaling are tolerable and in cases of high signal-to-noise ratio where high speeds of signaling are required.

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Early Electrical Machines

BERN DIBNER
FELLOW AIEE

In this second article of a series on pioneering investigations in electrical science, the first electric generator is described and an account is given of the early investigations into the relationship between light and electricity as well as the ingenious machines and experiments devised to probe this relationship.

TO OTTO VON GUERICKE (1602-1686), burgomaster of Magdeburg for 35 years, goes the honor of having constructed and made public the first electric machine. He is better known as the inventor of the air-pump (c. 1645) and the promoter of a device to demonstrate air pressure in an experiment considered among the most dramatic in the history of science. In this demonstration, made before the assembled Diet of Ratisbon, he applied two teams of eight horses each to pull apart two copper hemispheres fitted carefully together, from which the air had been exhausted by his vacuum pump. The teams strained but the hemispheres did not part. However, when the stop-cock leading to the sphere was opened, the air rushed in and the sphere parted. This dramatic demonstration of air pressure so overshadowed Guericke's work in electricity that very little attention was paid to his electrical experiments by his scientific contemporaries.

Fig. 1. Otto von Guericke, Burgomaster of Magdeburg and inventor of the air pump.

The electric machine that Guericke built and with which he experimented in order to study the phenomena of gravity and attraction was described in his book "Experimenta Nova Magdeburgica," published in Amsterdam in 1672. This publication also described electric conduction and repulsion, which had been described earlier by Cabeo. Gilbert had not only failed to notice repulsion, he denied its existence. Guericke recognized the significance of repulsion and experimented with it. He noticed that after a sulfur globe had been electrified by rubbing, a body would first be attracted to it and, on contact, be repelled. If this body then touched any other body but the sulfur globe it would again be attracted to the globe. Guericke had constructed his machine so that the globe on its shaft could be lifted from its supports and carried about the room as shown in Fig. 2. He observed that a feather floating in the air would be attracted, then repelled, by the globe, that the feather preferred attraction to "the points of any object whatsoever before it, and it is possible to bring it to where it may cling to the nose of any one." Pointed conductors were thus most effective in attracting an electrified body.

This electric machine was the first rotating frictional (or triboelectric) generator; it consisted basically of a sulfur ball revolving on a shaft. The ball was formed by pouring molten sulfur into a spherical glass container "about the size of a child's head." When the sulfur cooled, the glass shell was broken away leaving its spherical form; into this an iron shaft was inserted and the assembly was then mounted on the bearing supports of a wooden frame. When revolved, a dry hand was applied to the revolving sphere. This electrified the sphere which was then shown to attract paper, feathers, lint, and other light objects. It was also noted that these adhered to the sphere as it rotated and this prompted Guericke to compare it to objects clinging to the surface of the earth. He thus assigned an electrical cause to the attraction of things to the earth's surface in contrast to Gilbert who believed this attraction to be of a magnetic nature. Most

Partial text of "Early Electrical Machines," published by the Burndy Library.
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Fig. 2. The first electric generator.

important of all, Guericke observed small sparks in the discharge and heard their crackling sound. Thus, for the first time, someone actually saw and heard what heretofore had been manifested only as a gentle attractive force. Guericke noted that "if you take the globe with you into a dark room and rub it, especially at night, light will result"; further, "there is likewise a virtue of sound in this globe, for when it is carried in the hand or is held in a warm hand and thus brought to the ear, roarings and crashings are heard in it."

With the new machine, Guericke observed the repulsion of what we would call similarly electrified bodies. One such body which had first been attracted to the sphere was now repelled by the sphere but attracted to other bodies. It was then again attracted to the sphere after having come in contact with a finger, or upon touching the ground. He also observed that a feather would move up and down between sphere and ground. Further observation showed that an electric charge traveled out to the end of a linen thread an ell (45 inches) or more long and that bodies became charged even if only brought close to a charged sphere. The phenomena of both electric conduction and induction were thus observed and demonstrated by Guericke; they became the subject of extensive investigation by later electricians. Gilbert had noticed the extension of magnetic influence along a magnetized bar; Guericke observed the same behavior of the electric charge along an electrified body.

Thus, by placing a linen thread in contact with the electrified globe, Guericke took the first step in the ever-extending process of electric transmission of power, albeit the distance traveled was a little more than a yard. Stephen Gray, a half century later, extended the span of transmission to over 250 yards of linen thread.

An improvement in the construction of electric machines was mentioned by Sir Isaac Newton in a letter to the Royal Society in 1675. Newton was the first to note that ". . . the electrick Vapour which is excited by the friction of the Glass against the Hand . . . will sometimes push against the Finger so as to be felt." Thus, in Newton's words, were the visual and audible properties of electricity augmented by that of its tactual property.

With the phenomena of electrical behavior challenging the philosophers of the 1600s for a rational explanation, and not helped by the classic texts of the ancients, it is understandable that the new men found the novel art of experimentation more intriguing than the older one of hunting supporting texts and quoting authority. So it was that the new science of electricity proved to be the guiding light that led other men of science from millennial darkness into the age of reason.

FRANCIS HAUKSBEE

ELECTRICAL EXPERIMENTING continued in England during the early 1700s and a key figure in this was Francis Hauksbee. Little is known of him, not even the years of his birth or death, but it is recorded that he was a curator of experiments and instrument maker to the Royal Society, and that he was elected a Fellow in 1705. The book describing his work contained many "firsts," particularly the relationship between light and electricity. He exhausted the air from a glass vessel containing some mercury and on shaking it observed a light glow. This he called "mercurial phosphorus," a phenomenon observed earlier by Jean Picard and noted in Paris in 1675 as the light produced in a barometric tube. He

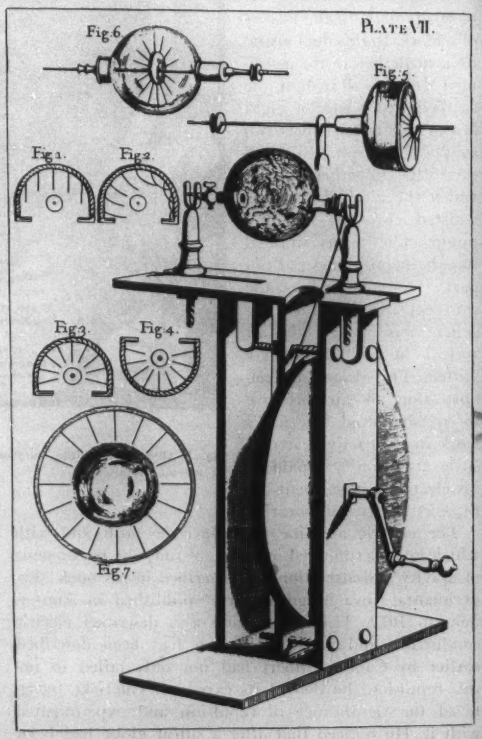


Fig. 3. Machine devised by Francis Hauksbee to investigate the relationship between light and electricity.

then contrived an important and dramatic experiment in which a glass receiver was placed upon a vacuum pump table and its air was exhausted. A tube was sent part way into the receiver and had its lower end fitted into a dish containing three pounds of mercury. When a valve was opened, air pressure rushed in through the mercury and up the tube shooting drops of mercury in a jet against the sides of the vessel, creating a luminous shower on the vessel's inner walls in a fiery cascade, so that the "Light darted thick from the Crown of the included Glass, *like Flashes of Lightning.*" Little did Hauksbee know what profound truth he was stating nor dream of the sciences and industries that would follow from that luminous cascade.

At a time when light of any kind was so much sought for, a new form of luminescence greatly excited Hauksbee's interest. He thereupon extended his experiments with vacuum vessels. To determine the nature of this new light, he placed pieces of amber in the vessel and arranged two woolen pads to be rubbed by the amber within the exhausted glass. A glow was created, one he could see at a distance of three or four feet, and one that grew more intense with better vacuum.

In further experiments, he soaked the woolen pad in a saltpeter solution and found that flashes replaced the glow. He rubbed glass on glass, glass on oyster shells, oyster shells on wool. Then a simple idea struck him. Instead of working under difficulties within the vessel, why not try some experiments upon the glass container. And so he constructed a new and revolutionary machine shown in Fig. 3 (illustration marked Plate VII). This consisted of a glass globe about 9 inches in diameter with trunnion mounting like a lathe, so that it could be rotated by a crank, wheel, and belt.

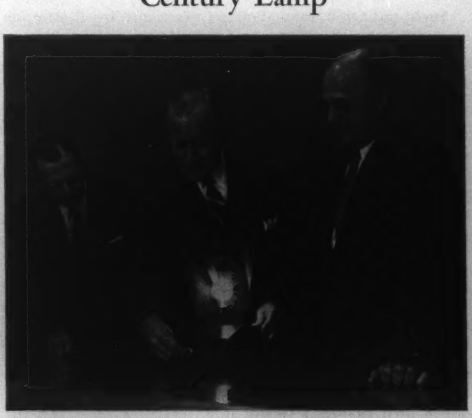
One trunnion was hollow so that air could be drawn from the globe. When he revolved the globe and held a dry hand to its surface, a purple glow, more brilliant than any previously made, formed in the globe, and this glow was "so great, that a large Print, might without much difficulty, be read by it; and at the same time, the Room, which was large and wide, became sensibly enlightened, and the Wall was visible at the remotest distance, which was at least 10 Foot." The glow diminished as air was admitted to the globe. A finger, brought within an inch of the globe while it was being rotated and rubbed, caused a light to form under the finger.

With enough new observations, Hauksbee tried to formulate a general theory covering them all, and although he tried, he remained uncertain, for he was primarily an experimenter. Later, he replaced the glass globe by a glass cylinder and observed an attractive force or wind upon a finger held near the revolving and rubbed cylinder. This led him to place a wire arch as shown in Fig. 3 (Plate VII, Fig. 1) above his machine, and from this he let a number of woolen threads hang. The simply rotated sphere or cylinder caused the threads to flap in the air eddy produced by the rotation, as shown in Fig. 3 (Plate VII, Fig. 2), but when a hand was placed upon the rotating cylinder, the threads stiffened into radial rays accompanied by light and by crackling sounds. In changing the position of the rotating cylinder from horizontal to vertical, the threads still pointed towards the cylinder's axis. He observed that "the Light threw itself abroad vigorously, and settled in small lucid sparks upon the ends of the torn Threads; looking there like so many little Stars, seen by a good Telescope in the Milky Way."

It has been claimed that Guericke's machine was not designed primarily for electrical investigation and he has, therefore, been awarded more credit, as an early electrician, than he deserved. However, it must also be shown that Hauksbee's first four papers printed in the "Transactions of the Royal Society," 1705, although concerned with electrical phenomena, were labelled as "phosphorescent." "Electricity" at that time concerned itself only with the attraction of light bodies.

(In the next issue, the scene shifts to the Continent. Investigations into the nature of electricity increase in tempo with the first demonstrations on men and machines hinting at the enormous power inherent in this phenomenon.)

Century Lamp



One-hundred-year lamp is turned on by R. J. Cordiner, president of the General Electric Company. The bulb is a replica of Thomas Edison's first practical incandescent lamp and will burn continuously atop Edison's desk in the GE Research Laboratory at Schenectady, N.Y. Improved materials and manufacturing techniques developed by GE give the replica an anticipated life of more than a century, and a special power source insures that the bulb will burn night and day without interruption at least until 2057. At left is Dr. W. D. Coolidge, director-emeritus of research at GE whose many scientific achievements include the development of ductile tungsten. This discovery made possible long-life incandescent lamps. Dr. Guy Suits (*right*), GE vice-president, looks on.

The Westinghouse Testing Reactor

A. R. JONES
MEMBER AIEE

Nuclear radiation is known to produce drastic changes in some structural materials. This reactor will provide data on these effects thereby facilitating nuclear power plant design. The importance of this problem for the design engineer is discussed and meaning of the term radiation is examined so that the purpose and design details of the reactor can be better understood.

NUCLEAR RADIATION is known to produce drastic changes in the properties of some but not all otherwise useful structural materials. The Westinghouse Testing Reactor (WTR) is a tool to be used in obtaining data on these effects.

The nuclear radiation, with which the WTR is concerned, consists of particles and photons of energy emitted from the core of a reactor in which fission is or has been taking place.

Such radiation may damage materials by destroying their ionic bonds, displacing atoms from a crystal lattice, producing isotopic transformation, or generating local hot spots of extreme temperature.

Environmental conditions such as pressure, temperature, flow velocity, etc., of the material coolant affects the damage rate.

For these reasons, there is no substitute for a testing reactor as a tool in expanding the knowledge of radiation damage both to fuel elements and structural materials.

The Westinghouse Testing Reactor will be the first privately owned facility in this field. It will make available to industry and Government a reactor containing the following test space: One 6.5 inch diameter 48 inch length—suitable for 2,000 psi thimble; six 2.75 inch diameter 48 inch length—suitable for 2,000 psi thimbles; five 2.75 inch diameter 48 inch length—rabbit facilities; one 8 inch diameter—beam hole; sixty-six 2.75 inch diameter 48 inch length—low pressure thimbles; and fifty-one ½ inch diameter 40 inch length—high fast flux thimbles.

THE DESIGN ENGINEER'S PROBLEM

THE DESIGN ENGINEER, regardless of the item upon which he is working, is limited by his knowledge of materials from which he is to select his design. His task is made easy and his design is made closer to success in direct proportion to the amount of data he has at hand concerning the materials with which he desires to work. This statement is true of all kinds of design without exception, and it is no less true of the new field of atomic energy. Over the years, a vast storehouse of knowledge has been accumulated about the physical, chemical, metallurgical, and other properties of most of the metals, insulating materials, etc., which the design engineer uses in his day-to-day effort. However, when the design engineer turns to face the new field of atomic energy and attempts to design a nuclear reactor to serve as the heat source in a power plant, he is faced with certain new problems. In addition to all of the old conditions which had to be considered in the selection of structural materials, and among these one might list such conditions as pressure, temperature, stress, vibration, etc., the designer finds himself faced with a group of new problems which have to do with the influence of intense nuclear radiation fields. It is easy to dismiss this problem with the comment, "This is merely another parameter to be considered in the design." That statement is true but fails to take into consideration the size of the task involved in attempting to acquire performance data for hundreds of potential reactor design materials, which the designer may wish to examine in an effort to obtain the optimum selection. The fact is that the nuclear reactor design engineer has at his disposal today radiation performance information on a relatively small number of materials. The success of the struggle now under way to obtain competitive nuclear power depends in very large measure on the expansion of this list of materials.

A. R. Jones is with the Westinghouse Electric Corp., Pittsburgh, Pa.

THE MEANING OF NUCLEAR RADIATION

THE MEANING OF THE TERM "nuclear radiation" and why it has such an important place in the critical properties of reactor structural materials must be understood. Nuclear radiation is a general term which includes a number of types of radiations, some of which are particles of matter like the neutron, and some of which are photons of energy of an electromagnetic nature like the gamma ray. Table No. 1 lists the more important types of nuclear radiation. The neutron, the proton, and the beta particle, or electron, are considered to be basic building blocks of the atom as known today. The alpha particle is

Table I. Nuclear Radiation

Designation	Physical Concept	Electric Charge	Remarks
Neutron	Particle	None	Energy May Vary Widely
Proton	Particle	Positive (1)	
Beta	Particle	Negative (1)	High Speed Electron
Alpha	Particle	Positive (2)	Two Neutrons and Two Protons
Gamma	Electromagnetic Wave.	—	Photon of Energy
Fission Fragments	Particle	Positive (Many)	Atomic Nuclei

essentially the nucleus of a helium atom consisting of two neutrons and two protons. This combination of four building blocks is one of the most stable combinations in the structure of atoms. Gamma rays are electromagnetic waves or photons of energy depending upon the particular viewpoint. The fission fragments are strictly not radiations at all but are atomic nuclei which result when a large uranium atom fissions to break into two probably unequal parts, later forming two new atoms of material.

THE EFFECTS OF RADIATION

One of the effects of nuclear radiations is to cause atoms and molecules to become ionized or electronically excited, either directly or indirectly. The effect of such action is to lead to chemical changes, an effect which is particularly important where organic materials and water are concerned. The organic materials are important in reactor construction in connection with insulating materials, moderation, reflection, and shielding. Water is of importance in reactor design in connection with cooling, moderating, reflecting, and shielding the machine.

The effect of nuclear radiation on water is dissociation of the hydrogen and oxygen atoms resulting in the production of gas within the coolant system. Such gases may influence the heat transfer and have other deleterious effects on reactor operation.

Plastics are essentially pure organic materials and, hence, are susceptible to ionization damage. Important plastics, in certain cases, desirable for use in reactor design include stryrene, nylon, polyethylene, and other materials. The types of damage encountered in plastics include changes in impact strength, tensile strength, and embrittlement. This ionization effect is not particularly important insofar as metal structural materials are concerned.

Normally, beta particles and gamma ray photons produce negligible radiation damage in materials such as metals or graphite. However, this is not necessarily true for the heavy nuclear particles such as protons, neutrons, alpha particles, and fission fragments. In many cases, these types of radiation are found to be capable of displacing atoms in the crystal lattice of the metal or graphite and physical changes of a more or less permanent character can be observed in the structural material. Such characteristics of the materials as electrical resistance, thermal resistance, hardness, tensile strength, and physical shape are observed to change in materials exposed to such radiations.

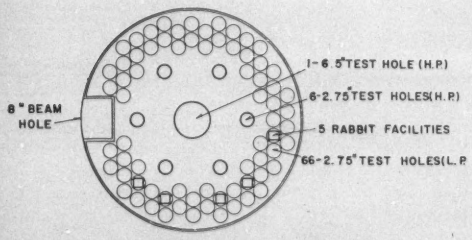


Fig. 1. Plan view at the midpoint of the vertical dimension of the test volume.

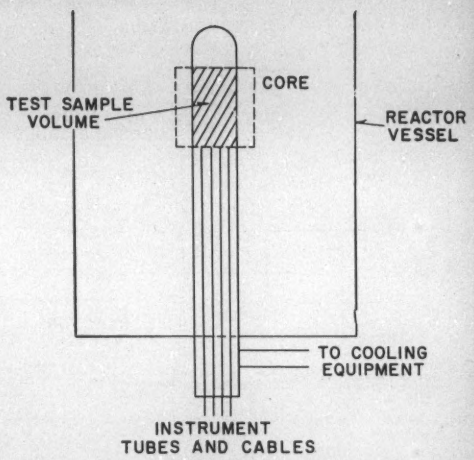


Fig. 2. One of the seven high-pressure thimbles to be incorporated in the Westinghouse Testing Reactor.

It is also considered possible that the damaging effect of fission fragments and fast neutrons may be due to the fact that both dissipate essentially all of their energies within a very small volume. It has been estimated that this small volume may attain a temperature of up to 2,000 F for a period of 10^{-10} seconds. At such high temperatures, distortion of the lattice equivalent to fusion or even vaporization is to be expected.

A third possibility is that by absorbing one of these particles, a material may be transformed into an entirely different element. The result is an impurity atom introduced into the original lattice. If present in sufficient numbers, such impurity atoms will undoubtedly affect the physical properties of the material.

Under certain conditions, it has been noted that corrosion and erosion of reactor materials has been influenced by radiation. The phenomenon is assumed to be a combination of the presence of nascent oxygen atoms released by the decomposition of the water plus destruction of the protective oxide coating by the impact of high energy particles.

The data indicate that elevation of operating temperatures alleviates the radiation damage. This has been explained on the basis that the individual atoms of a material are much more mobile with increased temperature, and that this aids the self-healing process inasmuch as atoms are more easily able to slip into and fill a vacancy if the temperature is high. This gives a clue to the fact that it is necessary to look at each material not only

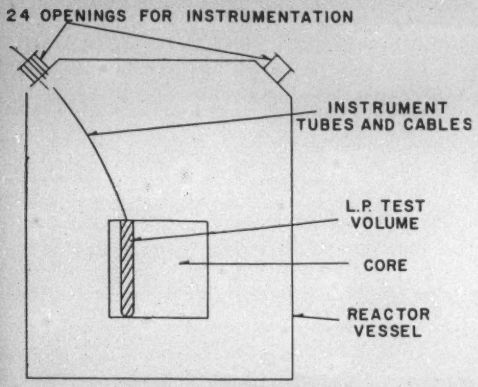


Fig. 3. Method of facilitating instrumentation of low pressure test samples.

in a general way, but also in the specific ambient conditions for which it is proposed to be used. For example, in many of the reactors under consideration at present, the structural materials in the reactor core are exposed to extremely pure water at pressures in the order of 2,000 pounds per square inch and temperatures in the range of 500 to 650 F. Other reactor designs propose different coolants at various temperatures and pressures down to atmospheric pressure and temperatures up to the vaporization temperature of sodium (1,620 F). There, it is apparent that the reactor designed to test materials must be capable of reproducing this same wide range of ambient conditions. It will probably never be possible to incorporate into a given test reactor all of the desirable flexibility to handle test specimens for every conceivable reactor design which has been or will be conceived in the fertile mind of man. However, it is necessary to make every effort to achieve such flexibility. The efforts which have been made in connection with the design of the WTR in order to obtain such flexibility are detailed in the following paragraphs.

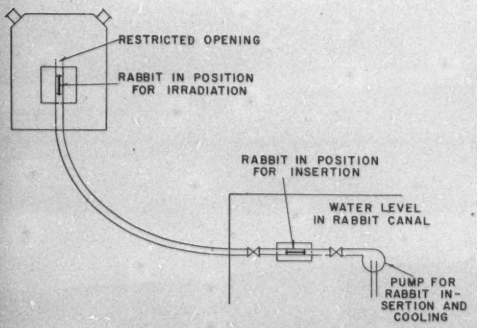

RESTRICTED OPENING
RABBIT IN POSITION FOR IRRADIATION
RABBIT IN POSITION FOR INSERTION
WATER LEVEL IN RABBIT CANAL
PUMP FOR RABBIT INSERTION AND COOLING

Fig. 4. View of the rabbit facilities.

TESTING REACTOR DESIGN CRITERIA

THE FOREGOING LIMITED DISCUSSION of the problems which the industry faces has set the stage to delineate the general design criteria and pertinent goals to be considered in the design of a testing reactor. The design of a testing reactor should try to achieve a machine which will give a very intense source of all types of radiation for this reason: to know the influence of radiation in conditions closely paralleling those in a power reactor, it is necessary to obtain in the testing reactor a

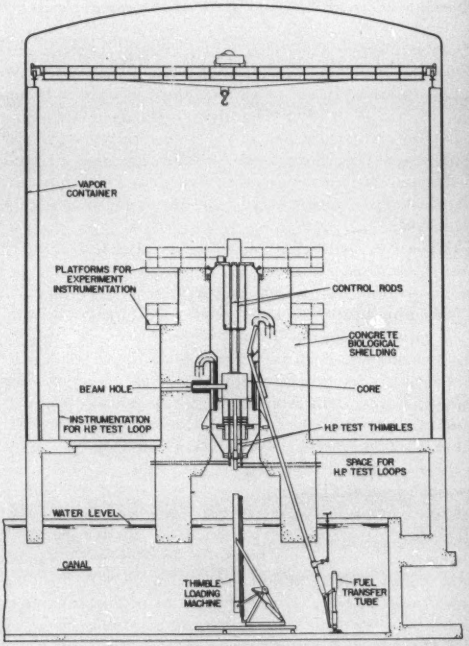


Fig. 5. Cross-section of the reactor building.

radiation level at least as high as that expected in the power reactors proposed to be developed and designed. Furthermore, it has been observed that radiation damage is a function not only of the intensity of the radiation to which the material is exposed, but also of the time for which the exposure is expected to occur. In order to make the most efficient use of the machine and to obtain the desired data in the minimum time, it is desirable therefore, to obtain an even higher radiation intensity than is expected in the ultimate power reactor so that the test period can be shortened. It also goes without saying that the value of the testing reactor is in direct proportion to the number of experiments which can be conducted simultaneously.

The preceding comments have made it clear that it is necessary to integrate into the reactor design provisions for providing ambient conditions over an extremely wide range of conditions for each of several different test specimens. In all likelihood, each individual specimen will be part of a test where the ambient conditions are peculiar to that test specimen and vary from the other test specimens in the reactor.

It is not known, at this time, how to produce a nuclear chain reaction and, hence, produce the desired source of radiation without obtaining appreciable amounts of heat as a by-product. In the case of the testing reactor, it is necessary to include in the design auxiliary heat dissipation equipment for 20,000 kw of heat.

It is not enough simply to irradiate the materials and then go away and say that the experiment is done. The effect on the materials must be evaluated by removing them from the reactor and performing further laboratory investigations to determine the changes in their physical characteristics, which is the desired information. Because many materials which have been exposed to intense neutron radiation also become radioactive, the handling of these materials in these laboratories presents somewhat of a safety problem. For these reasons, extensive and rather unusual laboratory facilities are required in connection with a testing reactor design.

WHAT THE TESTING REACTOR IS

After consideration of the problems and purpose and design criteria which form the basis for the decision to build the Westinghouse Testing Reactor, a specific description will now be given of this unusual tool which will be available for the use of industrial concerns participating in the atomic energy program.

The principal test volume of the WTR includes the nuclear fissionable material which serves as the source of the nuclear radiation and also includes the principal test volumes which will be discussed in greater detail later. The important portion, in fact, the heart of the test reactor, is this radiation producing core and where the principal test volumes are located. This volume is approximately 46 inches in diameter and 48 inches high.

Fig. 1, which is a plan view at the midpoint of the vertical dimension, shows some of the detail of this volume. The open area is occupied by the radiation producing core. The test volumes are shown by the circles. Provision has been made for inserting one 6.125-inch test thimble and six 2.5-inch test thimbles which can be designed, as shall be seen later, for the insertion of high pressure and high temperature samples. In addition, there are 66 holes where low pressure tests can be inserted and 5 holes where test specimens can be inserted and withdrawn rapidly without shutting down the reactor. These are referred to as rabbit facilities. In addition, an 8-inch beam hole—an empty tube through the shield—is provided for physics, instrumentation, and similar testing.

Fig. 2 demonstrates one of the seven high-pressure thimbles. This thimble, with its cooling equipment and instrumentation, is, in essence, a complete and separate reactor system. It contains all of the components of a complete power reactor except that it may or may not contain fuel elements, and if it does contain fuel elements they would not be sufficient to produce a critical mass and, hence, a chain reaction, without the assistance of the other fuel elements in the test core proper. Although it is necessary to do much of the inspection of the sample after it has been removed from the reactor, it is possible and necessary to do a certain amount of investigation in the course of the test. For this purpose, these test thimbles have been designed so that a large number of approximately ⅛-inch pressure and sampling lines as well as instrumentation cables can be inserted with the test specimen and brought out through the bottom of the test thimble and carried to appropriate external instrumentation.

In order to facilitate the instrumentation of low-pressure test samples, 24 openings have been designed around

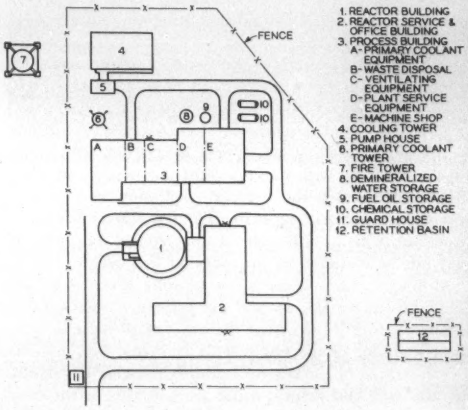


Fig. 6. Westinghouse Test Reactor plot plan.

the periphery of the top of the reactor vessel as shown in Fig. 3 so that pressure and sampling lines and instrumentation cables can be brought out from the low-pressure test volumes, and are so arranged that the reloading of fuel elements and other test specimens will not require removal of the test connections.

Reference was made to the rabbit facilities, shown in Fig. 4, which are so designed that small test specimens, without instrumentation connections, can be inserted in small autoclave type containers by hydraulic pressure. As long as the pump is in operation, the rabbits are held in position in the reactor core and cooled in the process. On disconnecting the pump, the pressure of the water in the reactor tank forces the rabbits to the removal position. Such facilities are of great value in short time tests and in the study of short-lived radioactive decay.

In addition to these test facilities, each of the 51 fuel elements contains a volume ½ inch in diameter and 40

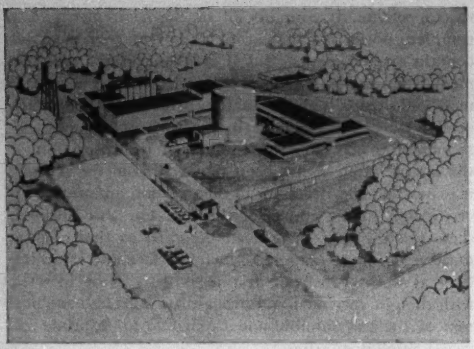


Fig. 7. Artist's conception of the finished plant.

inches long in its central supporting tube. These volumes are particularly suited to testing for the effects of high fast flux effects.

In addition to design of the testing reactor to provide information on radiation damage of materials, the test reactor has certain other functions which it is particularly well adapted to perform. These include such things as the production of radioactive isotopes. Of these isotopes, cobalt-60, with its important diagnostic and treatment functions in the medical profession has perhaps received the greatest publicity. The test reactor has many functions which, although of the utmost importance, may not be included in the scope of this article.

Although the foregoing paragraphs have indicated what the reactor can do and the principal test facilities, it may be in order to orient the heart of the reactor with the remainder of the test reactor facilities. Fig. 5 shows a cross section of the reactor building showing the shielding and core and principal test areas as well as the cross section of the water filled canal which runs below the reactor proper and serves as a shielding system during the transport of samples from the reactor to the hot laboratories where final evaluation of test results is carried out.

In the plot plan, Fig. 6 shows all the auxiliary facilities which must be provided along with the 46-inch diameter and 48-inch high heart of the materials testing type of reactor. The reactor building is indicated along with the connections to the services building where there are hot laboratories, control room, health physics, medical, and office facilities. Also indicated is the second building which contains the pumps and heat exchangers, etc., for the transfer of the 20,000 kw of reactor heat to the cooling tower, where it is ultimately dissipated to the atmosphere. In this same building are the waste disposal facilities, ventilation facilities, and shop facilities, as well as services such as heating and pressurized air facilities. The cooling tower, a stand tank which serves the purpose of pressurization on the primary system, and an additional stand tank which serves the purpose of fire protection for the general area are indicated in the plot plan. Outside of the reactor area proper is the retention basin where radioactive water is detained until the radioactivity decays to a level suitable for discharge into a local stream. The reactor building proper serves the additional function of serving as a completely closed plant enclosure which would contain the radioactive materials released in the improbable event of a major accident. This building is entered by means of double-door airlocks. One of these locks is of sufficient size to permit the entry of a truck. Inasmuch as this area is occupied by test personnel and, therefore, must be ventilated, arrangements are included to operate quick closing valves in the ventilation system to make the building completely airtight should radiation instrumentation warn of the release of radioactive material.

Fig. 7 is an artist's conception of the completed plant as it will appear, following final construction.

This has been a brief rundown of the Westinghouse Testing Reactor. It has been planned, and is felt sure will serve, as an outstanding tool to be used in the development of competitive atomic power. The facilities of this reactor will be available to industry and Government to assist in any way that it is applicable in the solution of problems raised in reactor development programs.

"Dine-A-Com" Sound System

An intercommunication sound system which will enable each patron of a drive-in restaurant to place his food order remotely and immediately, and to receive entertainment while awaiting delivery, has been placed on the market by the Radio Corporation of America. Dine-A-Com will enable restaurant operators to speed and improve service to patrons and to effect important economies.

The system comprises (1) individual talk-back speakers mounted on tray-holding posts in the restaurant's drive-in area, each post containing the daily menu; (2) a sound master console located in the order-taking room within the restaurant; (3) a pop-out annunciator box, mounted on the console, which instantaneously notifies the order taker of each incoming order and identifies the patron's post location; and (4) an automatic record player and an AM/FM tuner, to enable the drive-in restaurant to entertain patrons with recorded music or radio programs while awaiting delivery of their orders.

In operation, the patron, parked at a drive-in speaker post, needs only to press a button on the Dine-A-Com speaker to contact the order room. The depressed button automatically triggers the proper annunciator button on the console, and also sounds a buzzer and flashes a console light to attract the order clerk's attention. The order clerk establishes two-way communication with the patron merely by depressing a "talk" button on the console microphone. If other customers signal for attention while order clerks are busy, the annunciator buttons identifying their locations remain in view as reminders.

750-Mva Metal-Clad Switchgear

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METAL-CLAD SWITCHGEAR using magnetic-type power circuit breakers has had a top limit of 500 mva (megavolt-amperes) interrupting capacity for some time. However, studies begun in the early 1950's indicated that the loads to be expected in the foreseeable future required area substations with mva ratings about 50 to 65% larger than those obtainable with the 13.8-kv 500-mva breaker equipment. A 750-mva equipment will permit an increase in substation size within this range.

Development work on the 750-mva magne-blast circuit breaker was started at the conclusion of the studies. The first 750-mva metal-clad equipment was shipped in February 1956.

The width of the 750-mva unit and the 500-mva unit is the same—36 inches. The depth of the 750-mva units is increased by six inches. Thus, with an increase in floor space of less than 10%, an increase of 50% in capacity is secured.

The vertical lift arrangement is used because the breaker primary disconnecting contacts can be seen when the breaker is in the disconnected position. The breaker closing mechanism is blocked from operating during the elevating cycle and, conversely, the elevating mechanism cannot be operated if the breaker is closed. The small compact elevating gear motor has now been made easily removable. This facilitates the use of a manual crank when control power has been lost.

Polyester glass-laminate insulation is used in the box barrier on the breaker and for all conductor supports in both the breaker and the housings. It has improved electrical, mechanical, and moisture-absorption qualities as well as improved flame retardancy over the insulation previously available. The main bus bars of the metal-clad equipment are insulated with polyvinyl flame-retardant insulation.

The current transformers used are insulated with butyl compound molded on the core and winding. Above 200 amperes, they are of a new coiled-core, window type with grain-oriented steel and distributed winding. The window-type construction simplifies the primary connections and readily allows the use of up to three current transformers in each phase.

The interrupter consists of a ceramic type arc chute complete with magnetic-blowout coils and arc runners. These parts are assembled in a structure which is mounted and connected in such relation to the arcing contacts that upon opening the breaker, the arc is forced at a high rate of speed into the chute where it is elongated, cooled, and constricted so that, at an early current zero, the arc is interrupted.

To provide for rapid absorption of the increased arc energy involved in a 750-mva breaker, an increase of approximately 20% in the size of the arc chute had to be made both in length and height. A self-contained, one-piece chute was evolved which can be completely removed from the breaker by the loosening of three bolts.

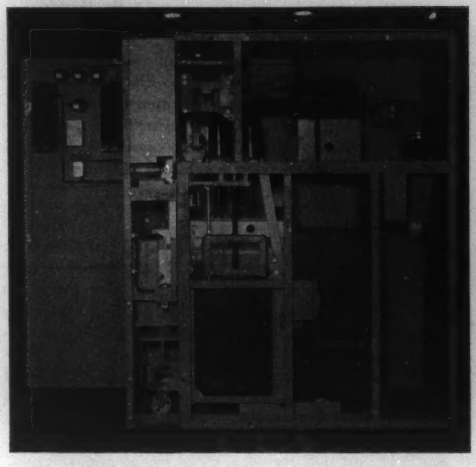

Fig. 1. Side view of 13.8-kv,, 750-mva unit with the circuit breaker in the disconnected position.

These breakers have been tested in the metal-clad housings on a large number of tests at all values. This requirement was set up in order to demonstrate that the breaker would not only meet the full range of values associated with its rating, but also would meet them repeatedly. Three phase tests were made at both the maximum design voltage of 15 kv and at the minimum rating of 11.5 kv.

Single phase tests were made according to the standard requirement of full current with 87% of maximum design voltage of 13 kv across a single pole. In addition, tests were made with the maximum design voltage of 15 kv appearing across a single pole. All tests demonstrate that the breaker satisfies the requirements for 5-cycle operation.

The solenoid mechanism used on other breakers of the magne-blast family is used on the 750-mva breaker. In addition, there is now available a new motor driven, spring operated, stored energy mechanism which can be used in place of the solenoid.

Digest of paper 57-180, "New 13.8-Kv, 750-Mva Metal-Clad Switchgear with Magnetic-Type Power Circuit Breakers," recommended by the AIEE Committee on Switchgear and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N.Y., Jan. 21-25, 1957. Scheduled for publication in AIEE *Power Apparatus and Systems*, 1957.

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A

X-Ray Photometers for Aircraft Generator Brushes

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The use of X-rays as a method of nondestructive quantitative chemical analysis is discussed. Two instruments designed for the measurement of barium fluoride treatment in aircraft generator brushes are described. Other applications of these instruments can be deduced from the method of analysis reviewed in the article.

CONSIDERABLE INTEREST has been shown recently in the use of Xrays as a method of nondestructive quantitative chemical analysis.[1,2,3] In particular, the method has been used with considerable success in the measurement of treatments in aircraft generator brushes.[4]

The two instruments have been built specifically for the measurement of barium fluoride (BaF_2) treatment in aircraft generator brushes, and a unique method of calibrating the instruments has been devised.

Other applications of these instruments may be determined from the following review of the method of analysis, and the calculations showing the range of intensities over which the present instruments will operate.

The method depends on the absorption of the materials in question, and the material being measured should have a high mass absorption coefficient in comparison with the base material. The ratio will be determined by the accuracy required and the tolerances that may be maintained on the base material.

In measuring BaF_2 in carbon, a suitable radiation is the characteristic Cu Kα radiation. It was obtained by operating a Cu target X-ray tube at 35 kv in conjunction with a nickel filter. This gives a radiation which is predominantly Cu Kα.

The mass absorption coefficient for BaF_2 is obtained as follows:[5]

$$\frac{\mu}{\rho}(BaF_2) = \frac{Ba}{BaF_2}\cdot\frac{\mu}{\rho}(Ba) + \frac{2F}{BaF_2}\cdot\frac{\mu}{\rho}(F) = \frac{137.4}{175.4}(359) + \frac{38}{175.4}(17.5) = 287.8$$

The mass absorption coefficient for C is 12. From these two absorption coefficients, it is evident that a 1% error in the brush thickness will only contribute 0.05% in the absorption reading.

Experience has shown that the instruments will balance over the treatment range of 1% to 7% on a brush 0.438 inches thick. To ascertain to what this is equivalent in terms of ratios of intensities, we must calculate the mass absorption coefficients for a 1% and 7% treatment and compare them. In actual practice, BaF_2 is added to a brush of uniform manufacture. Hence, a brush weighing 10 grams, after being impregnated with a 1% by weight treatment, weighs 10.1 grams. The mass absorption coefficient for the 1% treatment is obtained as follows:

$$\frac{\mu}{\rho}(1\%) = \frac{100}{101}\cdot\frac{\mu}{\rho}(c) + \frac{1}{101}\cdot\frac{\mu}{\rho}(BaF_2) = \frac{100}{101}(5.50) + \frac{1}{101}(287.8) = 8.30$$

Similarly for a 7% treatment, we have:

$$\frac{\mu}{\rho}(7\%) = \frac{100}{107}(5.50) + \frac{7}{107}(287.8) = 23.99$$

If we compare the intensities of the two beams after traversing the two brushes, we have:

$$\frac{I(1\%)}{I(7\%)} = \frac{\epsilon^{\frac{\mu}{\rho}(7\%)\cdot\rho(7\%)\cdot x}}{\epsilon^{\frac{\mu}{\rho}(1\%)\cdot\rho(1\%)\cdot x}}$$

where

$$\rho(1\%) = \frac{100}{101}\rho(c) + \frac{1}{101}\rho(BaF_2) = \frac{100}{101}(2.25) + \frac{1}{101}(4.83) = 2.28$$

and

$$\rho(7\%) = \frac{100}{107}(2.25) + \frac{7}{107}(4.83) = 2.42$$

$$\therefore \frac{I(1\%)}{I(7\%)} = \frac{\epsilon^{(23.99)(2.42)(.438\times 2.54)}}{\epsilon^{(8.30)(2.28)(.438\times 2.54)}} = 8.1\times 10^{18}$$

The instruments are capable of reading treatments of 7% to $\pm$0.01. If we calculate the ratio of intensities for a 7% treatment and a 7.02% treatment, we have

$$\frac{I(7\%)}{I(7.02\%)} = \frac{\epsilon^{(24.01)(2.42)(.438)(2.54)}}{\epsilon^{(23.99)(2.42)(.438)(2.54)}} = 1.390$$

Thus, a minimum ratio of intensity change is detectable of 1.390 over an entire range of 8.1×10^{18}.

The two instruments, that is, the so-called manually operated X-ray photometer and the self-compensating X-ray photometer, are similar in some respects to the

A special article recommended for publication by the AIEE Committee on Special Instruments and Auxiliary Apparatus.

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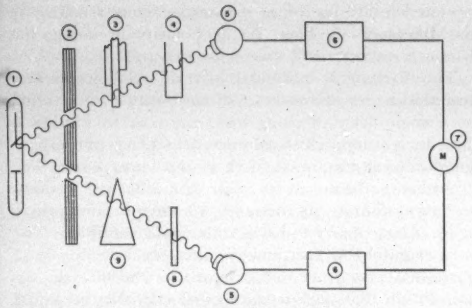
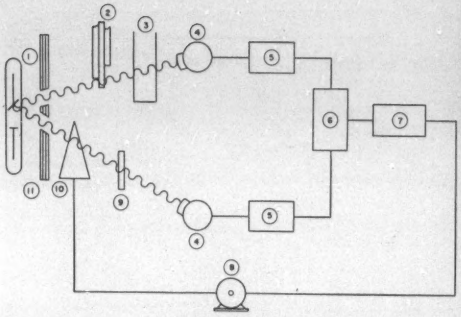
* When this paper was written, the authors included information and expressed opinions they believed to be correct and reliable. However, because of the constant advance of technical knowledge, the widely differing conditions of possible specific applications, and the possibility of misapplication, neither the authors nor their employer make any warranty with respect to, or assume any liability arising out of this paper, its contents, or its use.



1. X-RAY
2. LEAD SHIELD
3. ALUMINUM COMPENSATING BLOCK
4. BRUSH TROUGH
5. PHOTOMULTIPLIER TUBE
6. AMPLIFIER
7. METER
8. BeFe FILM
9. CALIBRATING WEDGE

Fig. 1. Block diagram of manually operated X-ray photometer.



1. X-RAY
2. ALUMINUM COMPENSATING BLOCK
3. BRUSH TROUGH
4. PHOTOMULTIPLIER TUBE
5. MAIN AMPLIFIER
6. DIFFERENCE AMPLIFIER
7. MOTOR AMPLIFIER
8. MOTOR
9. BeFe FILM
10. CALIBRATING WEDGE
11. LEAD SHIELD

Fig. 2. Block diagram of self-compensating X-ray photometer.

instrument described by A. C. Titus[4]. The main difference is that the instruments are null type which greatly simplifies the stabilization requirements of the X-ray machines. In addition, the instruments are designed for rapid production measurements.

BLOCK DIAGRAM OF PHOTOMETER

A BLOCK DIAGRAM of the manually operated X-ray photometer is shown in Fig. 1. It consists of an X-ray source able to produce 35 kv at 16 milliamperes (ma). The X-ray beam is split by a lead shield into two beams. One passes through the brush to be measured, and the other passes through a calibrating wedge. The resultant X-ray beams are detected by phototubes and, after proper amplification, compared and ultimately equalized or balanced by proper adjustment of the calibrating wedge. The position of the calibrating wedge is used as a means of reading the instrument.

The absorption coefficients of aluminum and barium fluoride are quite different. Without compensation, the instrument would be quite sensitive to anything which would change the hardness of the X-ray beam, such as shifting of the focal spot or voltage fluctuations applied to the X-ray tube. Consequently, an aluminum block is added to the upper beam to compensate for the aluminum calibrating wedge used in the lower beam, and a barium fluoride filter is added to the lower beam to compensate for the barium fluoride treatment in the brush when it is placed in the upper beam. The barium fluoride in the filter is roughly equal to the treatment in the middle of the operating range of the instrument. This combination makes the two X-ray beams traverse the same types of materials.

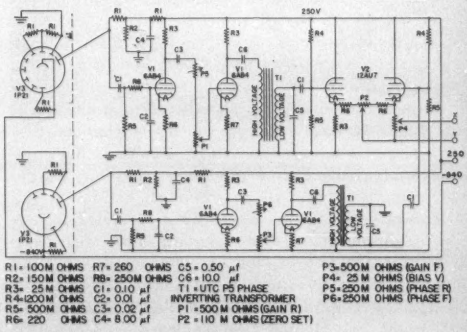
The aluminum block is adjustable and also serves as a rapid method of changing the range of the instrument. With the thickest brush to be measured, a 25-mill block of aluminum is used. As the thickness of the brush is decreased, a thicker block of aluminum is used.

A conventional *931* phototube is used as the detector. A thin film of activated zinc sulfide, using a Zapon lacquer as a binder, is painted over the window of the phototube. A one-mil foil of aluminum is wound around the phototube, and the tube is then given a light tight seal with black paper. Tubes are selected in pairs with roughly the same output with a given intensity of X-ray. The response of the tubes is linear, and no great care is needed in selecting the tubes.

The main amplifiers are conventional a-c amplifiers with a rectified output to drive the null meter. A matched pair of germanium diodes are shunted across the null meter. This gives the meter a nonlinear response, so that it is very sensitive in the null position and yet is protected if one of the X-ray beams is interrupted and the other is not. This would normally put a large signal across the meter.

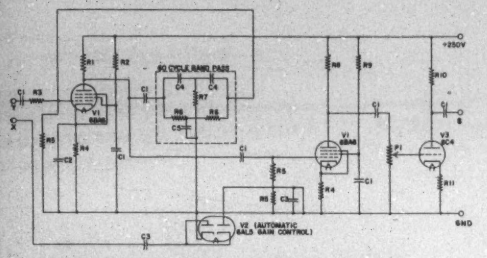
A conventional power supply is used and requires no regulation since the two amplifiers are balanced.

A block diagram of the self-compensating X-ray photometer is shown in Fig. 2. It is identical in its operation



R1 = 100 M OHMS
R2 = 150 M OHMS
R3 = 25 M OHMS
R4 = 1200 M OHMS
R5 = 500 M OHMS
R6 = 220 OHMS
R7 = 260 OHMS
R8 = 250 M OHMS
C1 = 0.10 μf
C2 = 0.01 μf
C3 = 0.02 μf
C4 = 8.00 μf
C5 = 0.50 μf
C6 = 10.0 μf
T1 = UTC P5 PHASE INVERTING TRANSFORMER
P1 = 500 M OHMS (GAIN R)
P2 = 110 M OHMS (ZERO SET)
P3 = 500 M OHMS (GAIN F)
P4 = 25 M OHMS (BIAS V)
P5 = 250 M OHMS (PHASE R)
P6 = 250 M OHMS (PHASE F)

Fig. 3. Phototubes and main amplifier of self-compensating photometer.



R1 = 100M OHMS R7 = 280M OHMS C1 = 0.10 μf P1=500M OHMS
R2 = 250M OHMS R8 = 50M OHMS C2 = 100 μf (DIFFERENCE GAIN)
R3 =1000M OHMS R9 = 75M OHMS C3 = 0.50 μf
R4 =200 OHMS R10 = 25M OHMS C4 = 0.05 μf
R5 = 500M OHMS R11 =1000 OHMS C5 = 0.01 μf
R6 = 560M OHMS

Fig. 4. Difference amplifier of self-compensating photometer.

with the manually operated photometer, with the exception that the readings are obtained automatically. The difference in the output from the phototubes is amplified and fed to a motor which is connected to the calibrating wedge. The motor adjusts the wedge so that the difference in the X-ray beams is nil. A drum is connected to the calibrating wedge, and the scales for different thicknesses of brushes are marked on the drum. Hence, the readings are obtained automatically.

CIRCUIT DESCRIPTION

THE PHOTOTUBES and main amplifiers are shown in Fig. 3. The phototubes are *1P21*'s which are selected *931*'s. They were used, because they have a higher signal-to-noise ratio. The tubes were prepared as outlined previously. The first stage is a conventional amplifier. A phase-shifting network is inserted in the coupling circuit of the second stage. The output of the second stage is coupled into the high voltage side of a *UTCP5* transformer. This network resonates at 60 cycles which is the frequency ultimately required to drive the motor. It gives a simple method of greatly increasing the signal frequency relative to the many odd frequencies which are equivalent to a noise background. The subtraction is performed in the cathodes of the *12AU7*. The adjustment of P_2 controls the zero setting of the instrument for small settings. The difference amplifier is shown in Fig. 4. The output of the first stage is fed through a 60-cycle band-pass network back to the input grid. A one megohm resistor is added in series with the grid to keep the output impedance from the network to ground high. This makes the stage a sharply tuned 60-cycle band pass filter. The bias on the filter stage is controlled by the signal level at the *12AU7* subtracting amplifier of the main amplifier. This acts in a manner similar to the conventional automatic volume control and tends to keep the output of the *6BA6* constant. The signal from the *6BA6* is fed to a *6C4* of low gain, which shifts the phase for proper operation of the motor.

The motor amplifier is shown in Fig. 5. The components are not critical, since the signal level is large. The polarity of the motor is set so that the calibrating wedge is moved in a direction to reduce the signal received by the difference amplifier. If the polarity is wrong, the system is unstable and cannot be balanced.

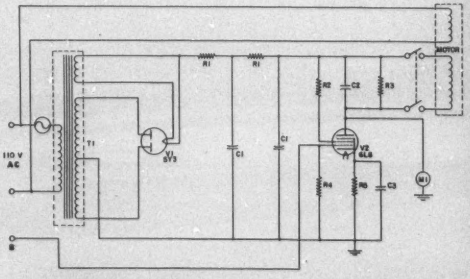
The machine is calibrated to read treatment in several thicknesses of brushes. All the scales are mounted on a single drum. Shifting from one scale to another is done by a switch which automatically places the proper compensating aluminum block in the upper beam. The drum has marked on it one scale with a balance position and two calibrate positions. As in the previous instrument, it is necessary to balance the main amplifiers. The balancing in this instrument must be done for both phase and magnitude, since it utilizes the 60-cycle signal. In the balance position of the switch, an equal amount of BaF_2 film is placed in the two beams. It corresponds to about the middle range of treatment read by the instrument. The balancing is done by adjusting P_1 and P_3 for gain, P_5 and P_6 for phase; and the degree of balance is read on a meter M_1 in the motor amplifier.

In the two calibrate positions, an equal amount of aluminum is placed in both beams corresponding roughly to the high range and the low range of the instrument. Instrument deviations are corrected by adjusting P_2 of the main amplifier. In normal operation, the instrument is checked for calibration during warm up, and then should maintain its calibration.

The completed instrument is shown in Fig. 6.

CALIBRATION OF THE INSTRUMENTS

AS POINTED OUT by Dr. A. C. Titus,[4] there are several methods available for calibrating the instrument; and each one has its own disadvantages. After several attempts at the more obvious methods, a rather indirect approach was taken which proved quite successful. Barium fluoride was mixed with Zapon lacquer in the ratio of 1:2 by volume and placed in a ball mill where it was uniformly dispersed. Strips of teflon were mounted on a frame and dipped into the mixture and withdrawn by a dip coater at a rate such that the rate of run back of the liquid was approximately equal to the rate of withdrawal of the frame. The films were allowed to dry and



R1= 1000 OHMS 10 W C1= 4 μf T1=POWER TRANSFORMER
R2= 2000 OHMS 2 W C2= 1 μf
R3= 1000M OHMS C3=10 μf
R4= 500M OHMS MOTOR=2 PHASE 4 WIRE INDUCTION
R5= 400 OHMS M1=OUTPUT METER

Fig. 5. Motor amplifier of self-compensating photometer.

then the teflon was carefully peeled off. The films were examined by X-ray absorption and found to be uniform to less than 1%.[6] The films were then stacked into piles containing 1, 2, 2, .5, 10, 20, 20, and 50 films. This combination of numbers allows a selection of any integral number of films from 1 to 110 to be used.

Adjacent sections were cut from the center of the films one inch square. One set of films was mounted in metal holders, and the other set was chemically analyzed. A correction was made for the slight absorption due to the lacquer. From the known amount of BaF_2 in the films, it was then possible to make up stacks of film with a known thickness of untreated carbon and calibrate the instruments in any desired range. Four different instruments have been built to date, and each one has been supplied with a set of calibrating films. This has made it possible to cross check the instruments very easily.

An attempt was made during the construction of the last instrument to substitute cadmium sulfide X-ray detectors for phototubes. This proved to be unsuccessful for many reasons. As in most semiconductor devices, there is a wide statistical range in the characteristics. It was impossible to select two cells which would remain balanced over the required range. In addition, since the response curves of the cadmium sulfide cells are nonlinear, a failure of a cell would require a complete recalibration of the instrument. Finally, there is a time delay from the time the cell is first irradiated until the cell reaches a stable response. This delay could not be tolerated in an instrument designed for production requirements.

All of the instruments have had sufficient field use to evaluate their suitability for the specific application of the measurement of barium fluoride treatments in aircraft brushes, and no serious defects have been detected.

Fig. 6. Self-compensating X-ray photometer.

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Tracking System Reports 72 Targets in 3D

A radar track-while-scan system, which automatically tracks up to 72 targets in three dimensions, has been developed by the Westinghouse Electric Corporation.

This is a hybrid digital-analog system in which error sensing is a completely analog function accomplished under the control of a digital computer which computes, controls and displays information on all 72 tracks. The result is a reduction of equipment required and an increase in accuracy of track over ranges considerably in excess of other types of tracking systems currently undergoing test.

Unique in the industry is the incorporation of three-dimensional information in the track-while-scan system, directly from a single radar source. In addition, individual monitors for each track are provided along with automatic track fault alarms, permitting one operator to monitor 12 tracks successfully. The computer components are made up of plug-in package units, using printed circuits and all static components.

Translators as Television Broadcast Repeaters

EDWARD GALUSKA

There are many communities throughout the country which, because of terrain problems, receive poor, if any, television service. Several methods for filling in these "holes" are discussed, the most economical being the translator type of booster.

THE EXTENT of a television station's coverage, under what we would like to consider normal circumstances, is always of prime concern to a station operator. When the station is located in an area where the terrain is hilly or actually mountainous, as in the Rockies and on the West Coast, the magnitude of this problem increases manyfold. In this case increasing station power does not solve the problem. Some means, therefore, must be contrived to put the station's signal into this shadowed area.

Another aspect to be considered is the fact that there are hundreds of communities throughout the country which, because of the same terrain problem, receive no television service at all. Until very recently it was a rather expensive proposition for a television station to install additional equipment to get its signal into these areas. In most cases, it was felt that the increased coverage involved was just not worth the added expense. Then, too, there was a great deal of controversy over the technical aspects of the problem. People living in these shadowed areas, demanding service as they had a perfect right to do, were left to devise their own methods. As a result, we have seen the growth of many cable systems throughout the country. Another outgrowth of this situation has been the mushrooming of on-channel boosters, or so-called "reflector stations" in various parts of the Northwest, Colorado, and California. This latter solution has become an extremely controversial issue, inasmuch as it has been branded illegal by the Federal Communications Commission (FCC), and has been the subject of many heated arguments.

About the same time these reflector stations were springing up, the problem of filling in "holes" in television coverage was brought to the attention of top technical and operating people throughout the country. This resulted in the establishment of several carefully planned and well-financed experimental setups for the purpose of determining the most economical, the most reliable, and the least interfering method for solving this weighty problem. The investigations and experiments were well backed by the manufacturing industry, the broadcasting industry, and the FCC. Experimental licenses were issued to various manufacturers of television broadcasting equipment, and to several television broadcast station operators. Throughout a period of two years, experimental work was carried on in various places. At Lawrenceburg, Tenn., a vhf on-channel station was set up boosting signals from WSM-TV in Nashville, Tenn. This project was undertaken by the station personnel of WSM-TV. At Vicksburg, Miss., the Radio Corporation of America (RCA) undertook an experimental investigation of a uhf booster installation. Adler Communications Laboratories installed a uhf booster which is still operating experimentally at Waterbury, Conn. Adler also undertook at its New Rochelle, N. Y., laboratories a program of investigation on translating or converting from one vhf channel to another, and also from one uhf channel to another. Experiments were also conducted with translating from uhf to vhf and vice versa. It was found that all these systems worked with varying degrees of success.

DIRECT BOOSTING

THE RESULTS OBTAINED through direct on-channel vhf boosting proved conclusively that although this system produced results, it could be made reliable with sufficient power to cover an average area only through the use of very special devices involving shielding between receiving and retransmitting antennas. On vhf, this shielding to eliminate oscillation was extremely elaborate and costly. Also, there was a definite limit to the power which could be reradiated over the desired area. The separation required between receiving and retransmitting antennas for vhf on-channel boosting became a handicap. As a result, the project to perfect this type of equipment was abandoned, as only marginal results could be obtained without an elaborate and costly installation.

It was found that uhf on-channel boosting was more workable, because the isolation problem between receiving and retransmitting antennas was partially solved by the fact that antennas at these higher frequencies can be made more directional and also considerably smaller than the vhf antennas. This results in less spacing between receiving and retransmitting antennas. In addition, higher output could be used because of the higher degree of isolation that could be achieved at low expense. Industry has great hopes for the possibility of utilizing uhf on-channel boosting. One of the problems is that considerably more data is required before the FCC can, in

Essentially full text of a conference paper presented at the AIEE Winter General Meeting, New York, N.Y., Jan. 21-25, 1957. Recommended for publication by the AIEE Committee on Television and Aural Broadcasting Systems.

Edward Galuska is with Adler Electronics, Inc., New Rochelle, N.Y.

collaboration with industry, prepare a set of rules that will fit into the allocations plan and also produce the fill-in characteristics that are required to obtain a maximum fill-in with a minimum of interference.

The system found to be most economical was the translator type of booster. Here, the frequency retransmitted is different from the one received. Almost any combination of uhf and vhf translation was found to be the most straightforward from an engineering standpoint, resulting in the simplest installation and the lowest cost with the greatest reliability.

Industry and the FCC agreed wholeheartedly on the concept of adopting a translator type of booster service for the purpose of bringing television programs to otherwise unserved areas. The upper 14 uhf channels were selected for this service simply because they were available. The rules written around the use of these 14 channels for television translator service have been prepared to keep installation and operating requirements to a minimum. However, it has been necessary to include sufficient technical requirements to make certain that the translator stations will not interfere with each other and will not interfere with other services important to the welfare and safety of the entire nation. As a result of the adoption of rules permitting television translator service, Adler Electronics has made available to television stations and communities requiring such systems the *UST-10* translator–transmitter for the purpose of bringing television programs to people who live in communities which are located in fringe areas or in areas which receive no television service at all.

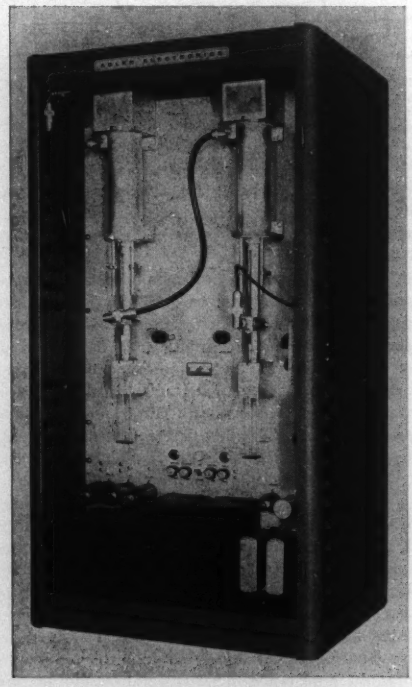

Fig. 1. Type *UST-10* television translator.

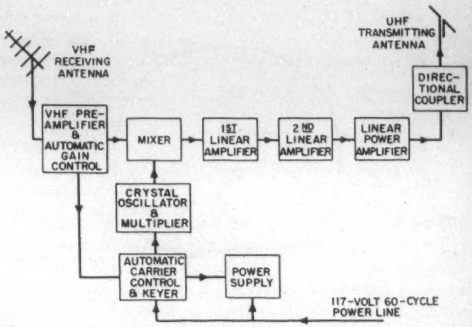

Fig. 2. Simplified block diagram of translator.

The *UST-10* 10-watt uhf television translator–transmitter, (Fig. 1) meets all these recently adopted FCC rules covering this type of service. The entire equipment, including the uhf linear output and driver stages, the vhf-to-uhf converter, and the vhf front-end equipment together with the power supplies, control circuits, and automatic International Morse Code identifying equipment, is contained in a single steel cabinet with front and rear access doors suitably interlocked. The cabinet is only 41 inches high by 22 inches wide by 17 inches deep. The equipment weighs approximately 250 pounds.

Fig. 2 shows a block diagram of the translator. Sufficient vhf head-end equipment is included in the standard unit to operate from a signal as low as 1,000 microvolts across a 75-ohm input. Additional vhf amplifiers, externally mounted, can be utilized to meet any reasonable vhf signal level and fading requirements. All vhf head-end equipment is furnished to operate on any one specified channel. Internal vhf head-end equipment contains automatic gain control to handle a 20-db signal fade range without appreciable uhf power output change. It also controls the transmitter power to turn the equipment on and off when the main station's carrier goes on and off. Conversion from vhf to uhf is accomplished at a fairly high level, so the problem of uhf noise has been eliminated. The mixer is a ground-grid stage extremely stable and free from intermodulation problems. It obtains its uhf injection signal from a temperature-controlled crystal oscillator with multiplier and amplifier stages all designed to meet FCC stability and spurious response requirements. The oscillator multiplier amplifier unit must be specified as to uhf output frequency. All other uhf components are adjustable in the field for operation on any one of the 14 uhf channels allocated for this type of service.

In addition, uhf head-end equipment in the form of uhf-to-vhf converters is available for use with this unit

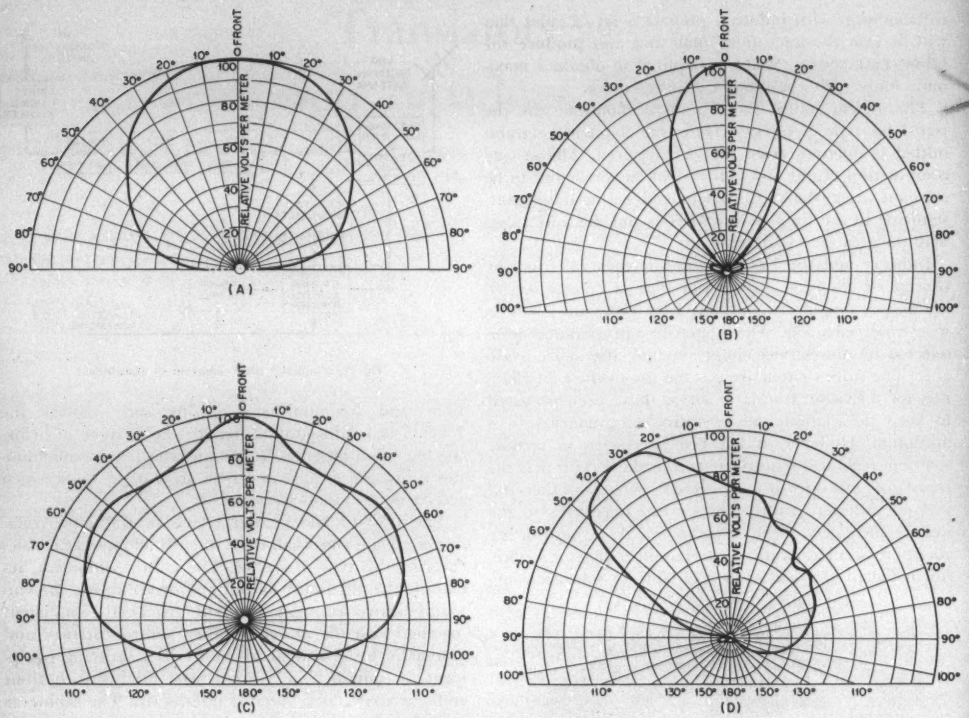

Fig. 3. Antenna radiation patterns.

so that the *UST-10* can be used for uhf-to-uhf translation. Such requirements are expected to present themselves where it is desired to operate a translator station in conjunction with another translator station, or where it is desired to extend the coverage of a uhf station by means of a translator.

Three linear amplifier stages are used to amplify the aural and visual output of the mixer stage up to a level of 10 watts peak visual and 5 watts aural. Bandwidth and linearity are such that the uhf retransmission is essentially identical to the vhf information received. Therefore, the quality of reception throughout the area covered by the TV translator station will not be degraded below that at the retransmitting site.

Metering facilities are included throughout by means of jacks in all cathode circuits of the grounded-grid amplifiers. An ordinary portable service meter is the only meter necessary to set the unit up in the field. In addition, probes are included to permit application of external sweep signals for alignment purposes. The output stage feeds the uhf transmitting antenna through a directional coupler. The portable external meter is used to measure power output and voltage standing wave ratio (VSWR) of the antenna and transmission line. Power on–off switching facilities for remote control are included. Thus, an inexpensive control circuit may be run several miles to a remote point where the licensed operator is to be located.

Shielding of all circuits and components is sufficient to permit operation of three or more *UST-10* translator–transmitters alongside each other in the same building or shelter when operated on alternate channels. In such cases, all receiving and retransmitting antennas may be mounted on the same supporting structure and a common a-c line may be used for all transmitters. Power requirements are 420 watts per transmitter from a 60-cycle single-phase 105-to-120-volt a-c source.

UNITIZED ANTENNA

A SPECIAL "UNITIZED" ANTENNA was developed for use with this equipment. It consists of a coplanar antenna having four horizontal folded dipoles stacked vertically in front of a reflector, all elements being fed in phase. Each unit has a measured gain of 9 db over an isotropic radiator, has an extremely low value of VSWR over the entire 6-mc bandwidth, and presents the necessary 50-ohm input impedance. This basic antenna unit is designed so that any number of units can be stacked

readily in any required combination, either vertically or horizontally, to give increased gain in any practicable pattern. Units can also be mounted in quadrature to produce an omnidirectional pattern.

Fig. 3 (A) shows the pattern obtained using one unit. The horizontal width here is 100 degrees at the half-power point and, as previously mentioned, has a gain of 9 db over an isotropic radiator. Two units mounted side by side produce the pattern shown in Fig. 3 (B)—44 degrees horizontal at the half-power points, with a gain of 12 db over an isotropic radiator. Another arrangement, again two units side by side, but this time bent at a 105 degree angle, produces the pattern shown in Fig. 3 (C)—180 degrees horizontal at the half-power points. This arrangement has an 8-db gain over the isotropic radiator. In all of these combinations, increased gain can be realized by vertical stacking—an additional 3 db for every doubling of units. Uneven power splits are also possible through the use of special power-splitting transformers. The pattern obtained from one such arrangement is shown in Fig. 3 (D).

To permit stacking of these units in the manner described, special harnessing transformers had to be designed and built. Their use allowed the presentation of the necessary 50-ohm impedance from any desired antenna array. The VSWR of these matching transformers, being very important, was again held to a value a great deal below that which is commercially acceptable. To give some idea of what was actually realized, eight standard stock antennas and seven extra matching transformers were used to set up an array—two side by side, stacked four vertically. With this array, a power gain of 64 was realized, which, in turn, meant that 400 watts of effective radiated power was available, considering transmission line losses. The measured VSWR of the entire system, including transmission line, was only 1.09.

Although both translators and antennas checked out satisfactorily at the laboratory, it was felt that some first-hand field experience was necessary to determine the actual performance of the over-all system. As a result, a stock translator system was installed on an experimental basis at Quincy, Wash. This site was selected because Quincy lies in a shadowed area, being completely surrounded by mountains. It also afforded a direct comparison between translator operation and vhf on-channel boosting.

Quincy is located 120 airline miles from Spokane, Wash., whose Channel 4 KXLY-TV was being boosted locally by one of the illegal reflector systems with a moderate degree of success. On top of one of these peaks which shadow Quincy, approximately 6½ miles from the town, the translator was installed to operate on Channel 78. This was the same site where the local reflector was located. Arrangements were made to have the same receiving antenna feed both translator and reflector systems simultaneously. Four unitized antennas were used, stacked vertically, producing an output of 200 watts effective radiated power.

Before the actual installation was made, however, it was necessary to determine the acceptability of this particular site. At this frequency and distance, the first Fresnel zone radius was calculated as follows:

$$\text{Clearance, feet} = 1140 \frac{d}{f}$$

where

f = frequency in megacycles
d = distance in miles

The clearance found necessary was 99 feet. A profile map was then plotted to determine the actual clearance available. The plot showed that more than sufficient clearance was obtained. Calculations were then made to determine what field strength could be realized in the town of Quincy. They were made on the following basis, expressed in dbm:

Translator output	+ 40
Line loss	− 2
	+ 38
Antenna gain	+ 15
	+ 53

Path loss was computed from the following:

$$\text{Attenuation} = 36.6 + 20 \log_{10} f + 20 \log_{10} d$$

To continue,

	+ 53
Path loss	− 112
	− 59
Receiving antenna gain	+ 10
	− 49
Line loss	− 2
	− 51

Thus, a signal level of −51 dbm was available over Quincy.

Using the equation

$$\text{dbm} = \log_{10} \frac{E^2}{Z \times 10^3}$$

where

E = level in microvolts
Z = impedance in ohms

It was calculated that 1,800 microvolts would be available across the receiver input terminals, which would require 500 microvolts (an extremely conservative figure) for a good snow-free picture.

The pattern laid down at Quincy was found to be a reasonable replica of the one previously shown in Fig. 3 (A), and extended approximately 20 miles in the forward direction. Field strength readings indicated that signals well above the necessary minimum for snow-free pictures were obtainable as far out as 17½ miles.

A comparison of the two pictures, that of the reflector operating on Channel 4, and that of the translator operating on Channel 78, showed that while the picture received from the reflector was plagued with ghosts, fading, and man-made interference, that of the translator was an extremely stable high-quality picture.

A Compressed-Air Dead-Tank Circuit Breaker

J. E. SCHRAMECK
MEMBER AIEE

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METROPOLITAN AREAS present their own peculiar problems in circuit breaker application. Power for many sections within these areas must be transmitted through underground cables, and previous transmission voltages for these and other sections no longer are economical for the loads involved. A circuit breaker for 138 kv, therefore, is indicated.

Load growth factors determine that the short-circuit interrupting capacity of these breakers should be 10 million kva for the foreseeable future.

In addition to the above factors, local ordinances and insurance regulations are unfavorable to the use of the conventional oil circuit breaker. Further, the cost of oil storage space and handling for such locations requires that a reconsideration be given to the type of circuit breaker to be specified.

The use of compressed-air circuit breakers is not new, even for the conditions indicated. However, previous designs have not retained certain desirable features of the oil circuit breaker which have been considered almost necessary parts of the circuit breaker by the American user. Two of these features are the provision for mounting bushing-type current transformers and the use of potential devices on the breaker actuated by voltage taps to the entrance bushings. It followed that retention of the grounded-metal-tank construction of oil circuit breakers in combination with compressed air interrupters would provide a logical solution to their requirements.

The interruption of 10 million kva with compressed air appeared to be a logical extension in capacity, inasmuch as interrupters for 69 kv and 5 million kva previously had been developed.

Also, it followed that the dead tank filled with compressed air could provide the necessary insulation between the interrupters and ground by suspending the interrupters within the dead tank and utilizing high dielectric strength of compressed air as an insulating as well as an interrupting medium.

With suitable means for operating the interrupters and provision for exhausting the air blast through the entrance bushings, a compressed-air circuit breaker has been developed. A conventional operating mechanism drives all three pole units. Accurately ground shafts rotating in "O" rings provide the mechanical connections between the external levers moving in atmospheric pressure and the lever system inside the high-pressure tanks so that air leakage between the two is eliminated. By this means, a cross-arm isolator is moved within each tank.

The bridging effect of the cross arm in the closed position connects the two interrupter assemblies of a pole unit in series, thus connecting two previously proved 69-kv interrupter assemblies for 138-kv operation. The position of the same cross arm in the open breaker position isolates both interrupter assemblies and the circuit. It should be noted that this cross arm is moved only by the external mechanism and remains either closed or opened. It will not reclose if air should be drained from the tank.

Pins are provided at each end of the cross arm which operate on a latch in each interrupter assembly. The "latched" position is obtained upon closing the breaker by upward motion of the cross arm.

Attached to the upper end of the latch is an exhaust valve. The upper side of this valve is arranged to be at atmospheric pressure, communicating to the bushing to which the interrupter assembly is attached. This bushing is hollow, with the upper end communicating to the outside atmospheric pressure for exhausting the air blast. As the exhaust valve is pulled from its seat by downward motion of the cross arm, a section within the interrupter assembly is thereby exhausted to atmospheric, thus creating a pressure difference between the section of the interrupter assembly and the air contained within the dead tank. This pressure difference, then, is utilized to obtain proper forces across pistons within the interrupter assembly to cause pneumatic operation of the interrupters. The pressure difference is obtained very near the point where forces are developed. The result is that pneumatic operation has a minimum effect on the over-all timing between application of the trip impulse and the opening of any one of the interrupters.

Reclosure of the interrupter contacts is initiated by disengagement of the latches from the cross-arm pins at a predetermined point in the downward motion of the cross arm.

The cross arm moves between lap-type contacts so that operation of the interrupters will be completed before isolation of the interrupters. Each of the two interrupter assemblies per pole consists of two interrupters controlled in their sequence of operation. One interrupter is paralleled by a low ohmic resistor. This interrupter opens first to interrupt fault current. The parallel resistor functions to control the circuit recovery voltage. A second interrupter interlocked with the first then opens in sequence to clear the resistor current.

In the development of this breaker, approximately 4,600 breaker operations were made. Of these, 1,800 were made under short-circuit and current-switching conditions. The remainder were mechanical operations to prove the mechanical adequacy of the working parts.

Digest of paper 57-174, "A New Compressed Air Dead Tank Circuit Breaker for Interrupting 10,000,000 Kva at 138 Kv," recommended by the AIEE Committee on Switchgear and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N. Y., Jan. 21-25, 1957. Scheduled for publication in AIEE *Power Apparatus and Systems*, 1957.

J. E. Schrameck and R. E. Kane are with the Westinghouse Electric Corporation, East Pittsburgh, Pa.

Reduced Transformer Insulation

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FELLOW AIEE

J. R. MEADOR
FELLOW AIEE

W. J. RUDGE
FELLOW AIEE

THE DEVELOPMENT of the Thyrite (registered trade mark) Magne-Valve station-type lightning arrester with its improved lightning protective characteristics made it possible to reduce power transformer BIL by two insulation classes under certain conditions. This was the culmination of a 5-year program which had three objectives: (1) to obtain service experience with the new arresters used with high-voltage two-step-down transformers; (2) to get additional information on switching surges occurring in service, and their effect on strength of transformer insulation; and (3) to study the long-time steady-state strength of transformer insulation.

In 1951 and 1952, 12 power transformers for 138-kv and 230-kv systems were built, having insulation levels reduced by two classes; that is, 450 kv BIL for 138 kv and 750 kv BIL for 230 kv. These transformers have operated satisfactorily since their installation.

Analysis of switching surge studies has convinced the authors that the more severe switching surges can be represented by a voltage wave rising to crest value in 500 to 3,000 microseconds. Studies of transformer insulation showed that a 1,000-microsecond front wave adequately represented this range and that the switching surge strength was not less than 1.3 times the crest of the transformer low-frequency test strength.

The long-time steady-state strength of transformers depends mainly on the maintenance of the dielectric properties of the oil in service. A new oil test cell has been developed which more nearly simulates the stress on the oil in modern high-voltage transformers. A field survey of oil, using the new test cell, showed that with modern preservation methods the oil in service is maintained at remarkably high levels.

The Thyrite Magne-Valve station arrester improved the lightning protection available by about 10% in lightning sparkover and 20% in discharge voltage, with very little change in the 60-cycle sparkover. To determine the switching surge protective level, tests were made on an arrester rated 195 kv with voltage waves rising to crest in 100 to 1,000 microseconds. These tests, which are plotted in Fig. 1, show that the protective level of the arrester in the switching surge region can be taken as the maximum of the arrester's 60-cycle crest sparkover.

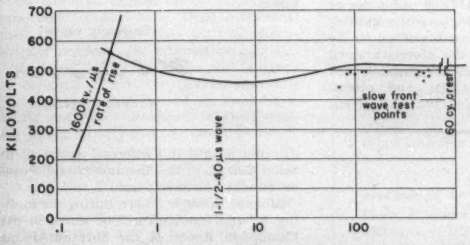


Fig. 1. Volt–time sparkover curve for 195-kv Thyrite Magne-Valve station-type arrester (maximum values).

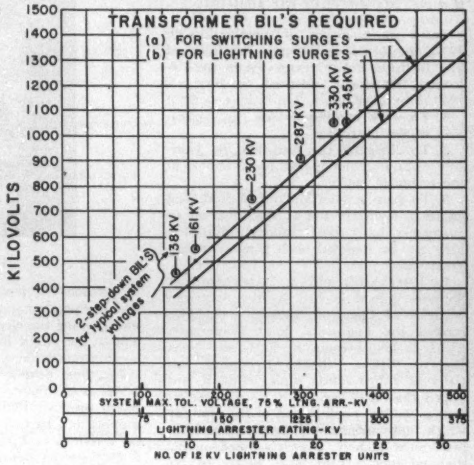


Fig. 2. Insulation co-ordination curves, showing adequacy of two-step reduction of insulation levels.

Minimum transformer BIL required for switching surges and lightning surges are shown in Fig. 2 for the conditions where a 75% arrester can be used on systems of 138 kv and above. Curve A was constructed by adding a margin of 15% to the arrester slow-front switching surge sparkover (maximum); dividing by 1.3 to give the minimum permissible low-frequency transformer test (crest); and converting to BIL by using the ratio between BIL and low-frequency tests (crest) in American Standard C57. Curve B was constructed by adding a margin of 20% to the arrester's maximum discharge voltage for a 10,000-ampere 10×20-microsecond surge.

For the present it is advisable to use bushings with BIL reduced only one class.

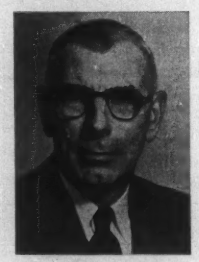
Digest of paper 57-19, recommended by the AIEE Committee on Transformers and approved by the AIEE Technical Operations Department for presentation at the AIEE Winter General Meeting, New York, N.Y., Jan. 21-25, 1957. Scheduled for publication in AIEE *Power Apparatus and Systems*, 1957.

E. M. Hunter, J. R. Meador, and W. J. Rudge are with the General Electric Company, Pittsfield, Mass.

INSTITUTE ACTIVITIES

A Message from the President

To All Members of the Institute:



Based on a survey of membership in 1947, our Board of Directors has followed an "Institute Policy" expressed in the following "Statement" adopted on June 15, 1950 (*Year Book*, 1954, Resolutions, p. 609):

1. To work continually for the unification of the profession.

2. To recognize the fact that the Institute finds its chief reason for existence in the technical field.

3. To handle questions on nontechnical affairs as necessary and as they arise, on an emergency basis until through unification they can be handled on a general professional basis.

In 1941, AIEE and the other Founder Societies, joined in 1942 by the American Institute of Chemical Engineers (AIChE), formed the Engineers' Joint Conference, which in 1945 became the Engineers' Joint Council (EJC). Although recognized initially as a Federation of Societies, it was hoped that EJC eventually would develop into a "Unity" organization of the type for which our membership had expressed a preference; namely, a society based on individual membership, with power to act and with adequate finances.

In reappraising this situation, the AIEE Board has reached the conclusion that there is little likelihood in the immediate future of welding the activities of the various technical and professional societies into one "American Engineering Association" to parallel the American Medical Association (AMA) and American Bar Association (ABA). Accordingly, for the present, the AIEE believes that the several established organizations should operate in accordance with the division of activities outlined below, and proposes to furnish moral and financial support on this basis.

1. *Electrical Engineering.* AIEE to provide the medium for advancement in technology in all branches of electrical engineering and to devote its efforts to this end. It is recognized that excellent services are being rendered in specialized areas of electrical technology by other societies. AIEE will co-operate with these societies. If mutually satisfactory arrangements can be effected, AIEE is agreeable to a merger into one organization for economy of operation and co-ordination of activities.

2. *Engineering other than Electrical.* EJC to provide the medium for co-ordination and co-operation on technological matters transcending the electrical field, and to present to the public the position of the engineering profession on technological matters.

For these purposes, a Federation of Societies is adequate. Accordingly, the AIEE Board proposes that, in the future, it will support and participate only in the technical activities of EJC.

3. *Engineering Education.* Engineers' Council for Professional Development (ECPD) provides the medium for guidance in engineering education (a) during high school preparation, (b) during the undergraduate and postgraduate collegiate periods, and (c) during the "engineer-in-training" period for a professional career. It could be delegated to represent the engineering profession in all educational matters.

4. *Professional Development and Economic Status.* National Society of Professional Engineers (NSPE) to provide the medium for the general promotion of the professional aspects of engineering in the eyes of the public, and be instrumental in the consequent enhancement of the economic status of engineers. The term "professional," as differentiated from technical and educational, is construed to include such activities as registration, employment practices, salaries and fees, legislation, and ethics.

5. *Co-ordination of Activities.* To implement this policy, the AIEE Board proposes that the several activities presently individually sponsored by these organizations be assigned according to the aforementioned delineation of scopes; namely, technological (EJC), educational (ECPD), and professional (NSPE). Separation and realignment of activities into these three categories could eliminate present confusion and wasteful duplication of effort.

If each of the organizations establishes itself in the fields indicated, it is believed that many of the advantages desired of a "Unity" organization may be realized. Eventually, it may be possible to incorporate them into one over-all engineering association.

6. *Expansion of NSPE.* AIEE has for many years recommended to its members that they should take steps to register as professional engineers. NSPE should put itself in a position to represent the profession more completely by expanding its individual membership organization to include those qualified members of the profession whose work does not by law require registration as well as registered engineers. Under such conditions, the AIEE Board proposes to recommend that all its members affiliate with NSPE.

In response to action by the AIEE Board of Directors on October 5, 1956, your President has discussed informally, personally, and/or in writing, the foregoing with the incumbent and incoming Presidents of many of the national engineering societies. They were requested to indicate, from a purely personal viewpoint only, whether they believed there is merit in further explorations. Their response has been encouraging.

On reporting this to the Board of Directors at its January 25, 1957, meeting, your President was instructed to proceed with the project. This letter is intended to be in the nature of a progress report to you.

I have yet to hear any engineer regardless of his society affiliation express opposition to unification of the engineering profession. The usual comment is, "the sooner the better," or "why doesn't someone do something about it?" If unification is ever to be accomplished, we must keep working at it continually. If you really believe in the project, as you have indicated through the survey of our membership, then I invite every contribution that you are able to make.

Sincerely yours,

M S Coover

President, AIEE

Montreal Will Be Host to AIEE Summer General Meeting

THE 1957 Summer General Meeting of the AIEE will take place June 24-28, in Montreal, Que., Canada. Meetings and several social events will be held in the Sheraton-Mount Royal Hotel.

Hospitality

An informal tea organized by the Hospitality Committee, will permit those attending to meet friends and make new acquaintances. If you are in Montreal, make sure not to miss this informal gathering in Salon C.-D.-E. of the Sheraton-Mount Royal on Sunday afternoon, from 3 to 5 p.m.

Monday through Friday, during the meeting, a buffet-luncheon will be served in the Champlain Room of the Sheraton-Mount Royal.

Smoker

Plan to renew old friendships and make new friends at the Smoker to be held in

the Sheraton-Mount Royal on Tuesday evening, June 25, 1957. Good food in the form of a cross-Canada buffet offering dishes from the Maritimes to the Prairies, good fellowship, and a top variety show will be the highpoints of this major event of the Summer General Meeting.

President's Reception

Thursday, June 27, features one of the most important events of the meeting: the President's Reception, followed by a dinner-dance listed as informal. Orchestration has been prepared for: square dancing, polkas, Virginia reels, fox trots, waltzes, cha-chas, etc.

Inspection Trips

A program of nine inspection trips has been arranged to allow delegates to become familiar with the engineering work being done in Canada.

On June 25, a TCA chartered plane will take 44 delegates to the site of the Bersimis Power Project for a full day inspection tour of the unique mountain-enclosed powerhouse, the gravity-type Desroches and Bersimis dams, the gigantic surge tank, etc. Located on the north shore of the St. Lawrence River some 340 miles from the City of Montreal, this development has an ultimate capacity of 1.2 million hp. It is one of the most important hydroelectric projects in the world. The round-trip time for the excursion will be approximately 15 hours. The main part of the journey will be made aboard a modern turboprop Viscount air liner.

Also on June 25, two other trips are planned—one in the morning and one in the afternoon. The morning trip will be a tour of Hydro-Quebec's Service Centre to see the microwave equipment that links Montreal, Charlesbourg, and Bersimis. The afternoon trip will be a visit to Lachine, a suburb of Montreal, to see a hydroelectric turbine and pump manufacturing plant.

One June 26, a morning trip to Montreal Locomotive Plant will be held. The emphasis will be on diesel electric locomotive production. Also on June 26, there will be an afternoon trip to the St. Lawrence Seaway, to see the work in the Lachine section extending to Beauharnois.

Another inspection trip on June 26 will be to Beauharnois, some 20 miles from Montreal to visit the Beauharnois Power Development, the main source of electricity for the Montreal metropolitan area. This visit will also include an inspection of the third and final section of the powerhouse now under construction. Once completed, this third section will increase Beauharnois' production to 2.16 million hp.

On June 27, an opportunity will be given 75 delegates to visit the Quebec Iron and Titanium Smelter Plant and the Shawinigan Water and Power Company's 230-kv Terminal Station at St. Joseph de Sorel.

On June 27, another inspection trip to Lachine has been organized to visit Northern Electric's Wire and Cable Plant, where the process of manufacturing communication cables will be demonstrated.

On June 28, a tour of inspection of a few of Hydro-Quebec's substations in the Montreal area, including the new 300-kv Terminal Station at Bout de l'Ile where some of

(Continued on page 522)

Future AIEE Meetings

Rectifiers in Industry Conference*
Morrison Hotel, Chicago, Ill.
June 4-5, 1957

Summer General Meeting*
Sheraton-Mount Royal Hotel,
Montreal, Que., Canada
June 24-28, 1957

Pacific General Meeting
Pasco, Wash.
August 28-30, 1957
(Final date for †TP—closed, ‡CP Syn.—June 14, CPMs—June 24)

AIEE-IRE Magnetic Amplifiers Conference
Penn-Sheraton Hotel,
Pittsburgh, Pa.
September 4-6, 1957
(Final date for †TP—June 4, ‡CP Syn.—June 19, CPMs—June 28)

Petroleum Conference
Penn-Sheraton Hotel,
Philadelphia, Pa.
September 9-11, 1957
(Final date for †TP—June 10, ‡CP.. Syn.—June 25, CPMs—July 5)

AIEE-IRE Industrial Electronics Conference
Morrison Hotel, Chicago, Ill.
September 24-25, 1957
(Final date for †TP—June 24, ‡CP Syn.—July 10, CPMs—July 19)

AIEE-IRE-IIT-NU-U of I National Electronics Conference
Hotel Sherman, Chicago, Ill.
October 7-9, 1957
(Final date for †TP—July 7, ‡CP Syn.—July 22, CPMs—Aug. 1)

Fall General Meeting
Chicago, Ill.
October 7-11, 1957
(Final date for †TP—June 7, ‡CP Syn.—July 24, CPMs—Aug. 2)

Reliability and Quality Control in Electronics Conference
Silver Spring, Md.
October 10, 1957
(Final date for †TP—July 10, ‡CP Syn.—July 25, CPMs—Aug. 2)

Feedback Control Conference
Chalfonte-Haddon Hall Hotel
Atlantic City, N.J.
October 16-18, 1957
(Final date for †TP—July 16, ‡CP Syn.—July 31, CPMs—Aug. 10)

Machine Tool Conference
Hotel Schroeder,
Milwaukee, Wis.
November 4-6, 1957
(Final date for †TP—Aug. 5, ‡CP Syn.—Aug. 20, CPMs—Aug. 30)

Magnetism and Magnetic Materials Conference
Park Sheraton Hotel,
Washington, D.C.
November 18-20, 1957
(Final date for †TP—Aug. 19, ‡CP Syn.—Sept. 3, CPMs—Sept. 13)

AIEE-IRE-ACM Eastern Joint Computer Conference
Park Sheraton Hotel,
Washington, D.C.
December 8-11, 1957
(Final date for †TP—Sept. 9, ‡CP Syn.—Sept. 24, CPMs—Oct. 4)

Winter General Meeting
Hotel Statler,
New York, N.Y.
February 2-7, 1958
(Final date for †TP—Nov. 1, ‡CP Syn.—Nov. 15, CPMs—Nov. 25)

South West District Meeting
Tulsa, Okla.
March 31-April 2, 1958
(Final date for †TP—Dec. 31, §DP Syn.—Jan. 15, DPMs—Jan. 24)

Middle Eastern District Meeting
Washington, D.C.
April 28-30, 1958
(Final date for †TP—Jan. 28, §DP Syn.—Feb. 11, DPMs—Feb. 21)

Summer General Meeting
Buffalo, N.Y.
June 23-27, 1958
(Final date for †TP—March 21, ‡CP Syn.—April 8, CPMs—April 18)

Pacific General Meeting
Sacramento, Calif.
August 19-22, 1958
(Final date for †TP—May 19, ‡CP Syn.—June 3, CPMs—June 13)

AIEE-IRE-RETMA-SMPTE National Electronics Conference
Chicago, Ill.
October 13-15, 1958
(Final date for †TP—July 14, ‡CP Syn.—July 29, CPMs—Aug. 8)

Fall General Meeting
Pittsburgh, Pa.
October 27-31, 1958
(Final date for †TP—June 27, ‡CP Syn.—Aug. 12, CPMs—Aug. 22)

*Final date for submitting papers—closed
†TP—Transactions Paper
‡CP Syn.—Conference Synopsis
CPMs—Conference Manuscript
(The CP Syn. date is 10 days before the CPMs date)
§DP Syn.—District Synopsis
DPMs—District Manuscript
(The DP Syn. date is 10 days before the DPMs date)

Summer General Meeting, Montreal, Que., Canada, June 24-28, 1957

Tentative Technical Program

Monday, June 24

9:00 a.m. Radio Communications Systems

57-706. The Canadian Transcontinental Microwave System. *S. Bonneville,* The Bell Telephone Company of Canada

CP.* Simultaneous Transmission of Television and Telephone Multiplex Over a Single Microwave Channel on the Trans-Canada *TD-2* System. *U. C. P. Strahlendorf, A. J. Wade, H. E. Curtis*

57-707. Light-Route Microwave Systems in Canada. *A. J. Dinnin,* The Bell Telephone Company of Canada

57-647. A Canadian Point of View on Radio Frequency Spectrum Management. *C. M. Brant,* Department of Transport

CP.* New Automatic Frequency Control System Suitable for Single Sideband Reception and FM Transmission. *L. R. Kahn,* Crosby Laboratories, Inc.

9:00 a.m. Suburban Electrification

CP57-728. Symposium on Electrification of Railway Commuter Service Part I—Problems Confronting Railway Commuter Service. *T. F. Perkinson,* General Electric Company

CP57-729. Series Capacitors Applied to Rectifier Motive Power Units. *L. J. Hibbard, T. J. Bliss,* Westinghouse Electric Corporation

CP57-730. Factors Influencing Future Electrification of Railway Commuter Service—Part II. *H. F. Brown,* Gibbs & Hill, Inc.

CP.* Conclusion. *J. Stair, Jr.,* Pennsylvania Railroad

9:00 a.m. Dielectrics and Nucleonics

Symposium on Radiation Effects on Dielectrics

CP.* Measurements of Radiation Doses by Absorption and Luminescence Changes in Solids. *J. H. Schulman,* Naval Research Laboratory

CP.* Naval Research Reactor and Nuclear Research Program. *E. N. Stirewalt,* Naval Research Laboratory

CP.* The Control System of the Naval Research Reactor. *M. P. Young,* Naval Research Laboratory, *G. F. Wall*

CP.* Problems Associated with the Irradiation Testing of Transformers at High Temperature. *W. R. Langdon,* General Electric Company

CP.* The Effect of Nuclear Irradiation on Small Transformers and Materials at High Temperature. *J. C. Fraser,* General Electric Company

CP57-708. Effects of Electron Irradiation on the Electrical Properties of "Mylar." *E. L. Brancato, J. G. Allard,* U. S. Naval Research Laboratory

9:00 a.m. Magnetic Amplifiers

9:00 a.m. Relays and Power System Communications

57-655. Evaluation of Operating Principles with Microwave Relaying. *J. Berdy, H. J. Fiedler, F. C. Krings, A. J. McConnell,* General Electric Company

57-650. An Appraisal of Remote and Local Back-Up Relaying. *L. F. Kennedy, A. J. McConnell,* General Electric Company

CP57-656. A New Concept in Subtransmission Line Protection. *T. G. Brennan, C. G. Dewey,* General Electric Company

* Conference papers will not be printed by the Institute; however, they may be available at the meeting at the direction of the author.

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57-657. Meeting the Electric Service Requirements of Critical Process Industries. *H. L. Deloney, Jack Davey,* Louisiana Power & Light Co.

CP.* Relaying Associated with the Expansion of the Sabine River Works Electrical System. *W. A. Hammer, L. C. McGee*

9:00 a.m. Chemical Industry

2:00 p.m. Annual Meeting

Tuesday, June 25

9:00 a.m. Section Delegates Conference

9:00 a.m. Safety

CP.* Hazards in Reactor Operation. *R. M. Johnston,* Atomic Energy of Canada, Ltd.; *D. C. King,* CSA Testing Laboratories

CP.* Medical Aspects of Radiation Hazard Control in a Power Reactor Installation. *R. M. Taylor,* National Cancer Institute of Canada

9:00 a.m. Land Transportation

CP.* Description and Maintenance Procedures of Electrical and Air-Conditioning Equipment on Canadian Pacific Railway Company Stainless Steel Passenger-Car Equipment. *A. E. McGruer,* Canadian Pacific Railway Co.

CP.* Rehabilitation of Diesel-Electric Locomotive Electrical Equipment. *T. H. Murphy, R. L. Bogardus,* Westinghouse Electric Corporation.

CP.* A New Void-Free, Class "H" Insulation System for Traction Motor Field Coils. *G. L. Moses,* Westinghouse Electric Corporation; *S. MacBeth,* Canadian Westinghouse Co.

55-207. Multiple-Unit Rectifier Motive Power Inductive-Co-ordination Considerations on the New York, New Haven and Hartford Railroad. *L. J. Hibbard, F. T. Garry, G. N. Loomis* (Represented for discussion only)

56-256. The Lightweight Train—Its Power Supply and Auxiliaries. *J. L. Swarner* (Represented discussion only)

9:00 a.m. Dielectrics

Symposium on Thermal Evaluation

CP.* The Effect of Temperature and Gamma Radiation on the Mechanical Properties of Some Wire Enamels and a Silicone. *E. L. Mincher,* General Electric Company

CP.* Progress Report on the Thermal Evaluation of Varnishes. *P. L. Hedrick,* Minnesota Mining and Manufacturing Co.

CP.* Procedure for Establishing the Temperature Classification of Enameled Magnet Wire. *J. F. Dexter,* Dow Corning Corporation

57-709. Effect of Wire Metal on the Thermal Life of Enameled Magnet Wire. *J. H. Thomas, J. F. Dexter,* Dow Corning Corporation (Represented for discussion only)

9:00 a.m. Telegraph Systems and Data Transmission

CP57-705. Loading Coils for Ocean Cables. *E. L. Newell,* Western Union Telegraph Co.

CP.* Experimental Data Transmission—Digital Subset Using Magnetic Tape. *J. E. Schwenker,* Bell Telephone Laboratories, Inc.

CP.* Error Detection on Five-Level Telegraph Codes. *W. B. Blanton,* Western Union Telegraph Co.

9:00 a.m. Textile Industry

CP.* Process Instrumentation from Spinning to Finishing. *J. G. Langlois,* Honeywell Controls, Ltd.

CP57-713. Electronic Controls as Applied to Process Instrumentation. *A. D. Entwistle,* Du Pont of Canada, Ltd.

CP57-714. Adjustable Frequency Drives. *A. T. Bacheler, C. G. Helmick,* Westinghouse Electric Corporation

CP57-715. D-C Adjustable Speed Drives—A Prelude to Automation. *G. Forsberg,* Canadian General Electric Co.

CP.* A-C Commutator Motors and Their Application in the Textile Industry. *C. I. Sym-Smith,* Brown Boveri Canada Ltd.

9:00 a.m. Magnetic Amplifiers

9:00 a.m. Substations

CP57-717. Basic Concepts in the Design of Electrical Bus for Short Circuit Conditions. *A. C. Bates,* R & IE Equipment Division of I-T-E Circuit Breaker Co.

CP57-718. Temperature Rise and Joint Resistance Tests of Three-Phase Bus Assemblies of Aluminum and Copper. *E. K. Lanctot,* Aluminum Company of America

57-719. Grounding Practices for Direct Current Structures. Conversion Substation Subcommittee

CP57-720. Station Control Circuitry with Microwave Relaying. *B. F. Wirtz,* The Cleveland Electric Illuminating Co.

CP57-721. Remote Control of Generating Stations over Radio Channel. *R. H. Ferguson, W. W. H. Dean,* Canadian Westinghouse Co., Ltd.

2:00 p.m. Section Delegates Conference

2:00 p.m. Safety

CP.* Canadian Development in Defibrillation. *R. O. Heimbecker,* The Banting Institute, University of Toronto

CP.* The Ground Detector Problem in Hospital Operating Rooms. *N. L. Kusters,* National Research Council

CP57-643. The Canadian Electrical Codes and Committees. *F. R. Whatmough,* CSA Testing Laboratories

2:00 p.m. Land Transportation

CP.* Mercury-Arc Rectifiers in Urban Transportation. *J. T. Harvey,* Toronto Transit Commission

CP.* Comparison of Aluminum and Steel Subway Cars. *L. W. Bardsley,* Toronto Transit Commission

CP.* Ore Haulage on the Quebec, North Shore, and Labrador Railroad. *J. H. Miller*, QNS & L Railroad (A talk illustrated with motion pictures)

CP.* Ore Mining Transportation Equipment. *William Hendry*, Ontario Department of Mines

2:00 p.m. Dielectrics

Symposium on Gaseous Dielectrics

CP.* Time Studies of Corona Discharges. *L. A. Bornstein*, New York University

57-82. The Use of Sulfur Hexafluoride in Waveguides. *Tore Anderson, A. L. Reeves*, Airtron, Inc.; *W. H. Mears, S. R. Orfeo*, General Chemical Research Laboratory (Re-presented for discussion only)

CP57-242. The Effect of Space Charge on the Breakdown of Sulfur Hexafluoride in Nonuniform Fields. *Dan Berg, C. N. Works*, Westinghouse Electric Corporation

57-309. General Considerations of Toxicity of Gaseous Dielectrics. *David Lester*, Yale University. (Re-presented for discussion only)

57-710. The Electrical Conductivity of Chlorinated Hydrocarbons. *John Hart, A. G. Mungall*, National Research Council of Canada (Re-presented for discussion only)

2:00 p.m. Computing Devices

CP57-673. Matrix Analysis of Logical Networks. *E. J. Schubert*, Westinghouse Electric Corporation

CP.* Coded Binary Counters for High-Speed Operation. *A. W. Carlson*

57-674. The RCA Bizmac Tapefile. *J. A. Brustman, R. E. Montijo, J. M. Uritis*, Radio Corporation of America

CP57-675. Relay Scanning Design Technique Generates High-Accuracy and Speed in Analog-to-Digital Transducer Measurements. *A. F. Kay*, Non-Linear Systems, Inc.

2:00 p.m. Symposium on Power System Communication Planning

S. C. Bartlett, American Gas & Electric Service Corp., New York, N.Y.
C. W. Cogburn, Florida Power & Light Co., Miami, Fla.
G. E. Farmer, Tennessee Valley Authority, Chattanooga, Tenn.
E. S. Kocsam, Pennsylvania Electric Co., Johnstown, Pa.
K. O. Sten, Boston Edison Company, Boston, Mass.

2:00 p.m. Magnetic Amplifiers

2:00 p.m. Textile Industry

CP.* Wire and Cable in the Textile Industry. *G. C. Stinson*, Northern Electric Co., Ltd.

CP.* Motor Enclosures for the Textile Industry. *C. Bouggy*, Reliance Electric & Engineering Co., Ltd.

CP.* Getting the Most from Your Indicating Electrical Instruments. *J. H. Lee*, Bepco Canada Ltd.

Panel Discussion: Maintenance Problems on Electrical Equipment in the Textile Industry

Panel Chairman: J. G. McAllister, Courtaulds Canada Ltd.

Wednesday, June 26

9:00 a.m. Indicating and Integrating Instruments

57-559. A Self-Balancing Transformer Core Loss Bridge. *A. H. Foley*, General Electric Company

CP57-664. The Definition and Measurement of the Time Constant and Response Time of Thermal Converters. *F. L. Hermach*, National Bureau of Standards

57-651. An Improved Single Phase Watt-hour Meter. *J. G. Landry, J. F. Scamman*, General Electric Company

CP.* Design of a New Two-Stator Watt-hour Meter. *D. M. Smith*, General Electric Company

CP57-308. Measurement and Control of Minute Frequency Variations in Supply Systems, and Survey of the Present State of the Art. *R. Leonhardt, Rhode and Schwarz*, Munich, Germany. (Re-presented for discussion only by R. Feldt, Federal Telephone & Radio Corp.)

CP.* Electrical Standardization Procedures Abroad. *F. K. Harris*, National Bureau of Standards

9:00 a.m. Metallic Rectifiers

9:00 a.m. Symposium on Corona Effects of Dielectrics

CP57-716. Microammeter Equipment for High Voltage D-C Insulation Tests. *M. Kurtz, K. D. Robertson*, Hydroelectric Power Commission of Ontario

57-711. The Manometric Test for Internal Corona in Cables and the Autographic Mapping of Corona Spaces. *D. W. Kitchin, O. S. Pratt*, Simplex Wire & Cable Co.

CP.* Measurements of the Resistance of Insulating Materials to External Corona in Air. *W. T. Starr*, General Electric Company

57-690. Corona Measurement and Interpretation. *T. W. Dakin, J. N. Lim*, Westinghouse Research Laboratory

9:00 a.m. Communication Switching Systems

9:00 a.m. Computing Devices

CP57-676. Are Motor-Generator Sets Necessary as Buffers for Voltage Transients in Electronic Systems. *J. J. Gano*, Massachusetts Institute of Technology

CP57-677. Cycle and Delay-Time Considerations in a Real-Time Digital Computer. *Herbert Freeman*, Sperry Gyroscope Co.

CP57-678. The Economics of Component Parts Selection. *E. F. Fuegel*, IBM Corporation

CP57-679. Experiences in Setting Up a Sage Prototype Computer. *W. J. Canty*, Massachusetts Institute of Technology

9:00 a.m. Switchgear

57-724. The How and Why of Expulsion Fuse Cutouts. *R. A. Wood*, R & IE Equipment Division of I-T-E Circuit Breaker Co.

CP57-725. Insulation Phenomena of Compressed Air. *L. D. McConnell*, Canadian Westinghouse Co., Ltd.

57-726. The Use of SF_6 for High Power Arc Quenching. *W. M. Leeds, T. E. Browne, Jr., A. P. Strom*, Westinghouse Electric Corporation

57-637. A New 69-Kv Dead Tank Compressed Air Circuit Breaker. *J. P. Skillen, D. H. McKeough*, Canadian Westinghouse Co., Ltd.

CP57-727. Voltage Recovery Rates Associated with Transmission Line Faults. *W. F. Skeats, C. H. Titus, W. R. Wilson*, General Electric Company

9:00 a.m. Insulated Conductors

57-652. Thermal and Mechanical Problems on 138-Kv Pipe Cable in New Jersey. *A. S. Brookes, T. E. Starrs*, Public Service Electric & Gas Co.

57-660. The Calculation of the Temperature Rise and Load Capability of Cable Systems. *J. H. Neher*, Philadelphia Electric Co.; *M. H. McGrath*, General Cable Corp.

CP57-731. 1956 National Electric Code—A Review. *R. C. Graham, L. H. Selden*, Rome Cable Corp.

CP.* The Stability of Electrical Insulation on Control Cable. *G. C. English, R. H. Brown, R. R. Cope*

2:00 p.m. Industrial Power Rectifiers

CP57-696. Rectifier Equipment Developed for Industry in Canada. *J. J. Dravis, T. A. Carter*, Canadian Westinghouse Co., Ltd.

CP57-697. First Canadian Built Pumpless Rectifier. *R. H. Stuart, Janos de Warga*, Canadian General Electric Co., Ltd.; *Fred Langvee*, Aluminum Co. of Canada, Ltd.

CP57-698. Improvements to Ignitron Rectifier Vacuum Auxiliaries. *W. G. Clarkson, C. F. Currey*, Canadian Westinghouse Co., Ltd.

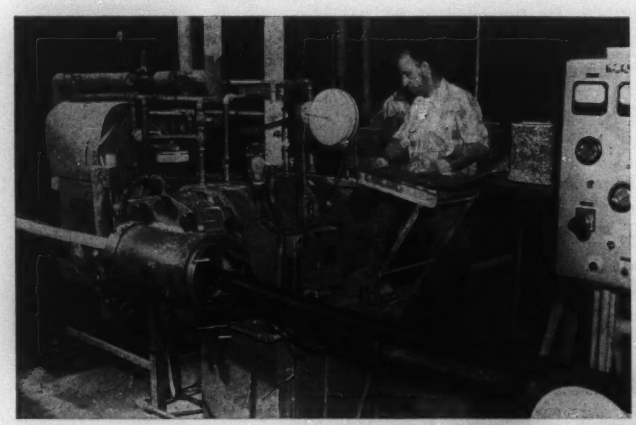
CP57-699. The Mercury Arc Rectifier in Urban Transportation. *J. T. Harvey*, Toronto Transit Commission

57-700. Application of a Mechanical Rectifier to a Cyclotron. *Jack Warren*, Singmaster & Breyer

2:00 p.m. Communication Theory

CP.* Human Information-Handling Capabilities. *J. C. R. Lickleider*, Massachusetts Institute of Technology

57-722. Some Relations between Television Picture Redundancy and Bandwidth Requirements. *K. H. Powers, H. Staras*, Radio Corporation of America.



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CP57-723. Statistical Encoding for Text and Picture Communication. *W. S. Michel*, Bell Telephone Laboratories, Inc.

CP.* Some Characteristics of the Homo Sapiens Signal Converter, Its Bandwidth and Signal-to-Noise Ratio. *G. C. Sziklai*, Westinghouse Electric Corporation

57-635. Information Theory Impact on Modern Communications. *Pierre Mertz*, Bell Telephone Laboratories, Inc.

2:00 p.m. Computing Devices

CP.* Combined Analog–Digital Simulation of Sampled Data Systems. *H. K. Skramstad*, National Bureau of Standards

CP.* Simplified Two-Channel Data Link for Real-Time Combined Analog–Digital Simulation. *J. L. Greenstein*, Astronautics Division of Convair

CP.* Acceptance Tests and First Applications of a Combined Analog–Digital Simulation System. *G. West*, Ramo-Wooldridge Corp.

Panel Discussion: Combined Analog–Digital Simulation Foregoing three authors as panel members

2:00 p.m. Switchgear

Symposium of the Working Group on Calculation of Faults in D-C Circuits

CP.* Short Circuit Characteristics of D-C Rotating Machines. *H. A. Brust*

CP.* Short Circuit Characteristics of Power Rectifiers. *W. A. Munson*

CP.* Short Circuit Characteristics of Batteries. *R. H. Kaufmann*

CP.* External Circuit Data. *D. C. McClintock*

CP.* Summary of Ratings of D-C Interrupters. *M. S. Carlson*

CP.* Application Guide for D-C Interrupters. *H. A. Brust*

2:00 p.m. Electronics

2:00 p.m. Feedback Control Systems

2:00 p.m. Insulated Conductors

57-732. Corona Level Scanning of High Voltage Power Cables. *F. H. Gooding, H. B. Slade*, The Okonite Co.

57-638. Paper Cable Saturants, European Preferences and Selection. *G. E. Bennett*, Dussek Bros. & Co.

CP.* Improved Cable Insulating Oils. *S. C. Bartlett, J. E. Morrow, E. S. Ross*

CP57-734. The Development of the Polyethylenes and Their Application to Cables. *E. E. McIlween*, The Okonite Co.

57-735. Liquid Thermosetting Resins Applied to Cable Installation and Maintenance. *E. W. Bollmeier*, Minnesota Mining & Mfg. Co.

2:00 p.m. Stationary Telemetering

Thursday, June 27

9:00 a.m. Wire Communications

9:00 a.m. Protective Devices

9:00 a.m. Computing Devices

9:00 a.m. Applied Mathematics

57-741. A New Method for Solving Simultaneous Equations by Block Elimination. *J. L. C. Löf*, The University of Connecticut

57-742. A New Application of the Hurwitz-Routh Stability Criteria. *Theron Usher, Jr.*, Yale University

CP.* Recurrence Relations in the Solution of a Certain Class of Nonlinear Systems. *A. A. Wolf*

57-743. Design Relationships for Iron-Core Filter Chokes. *Theron Usher, Jr.*, Yale University

57-744. Temperature Rise of Solid Junctions under Pulse Load. *E. J. Diebold*, International Rectifier Corp.

9:00 a.m. System Engineering

57-670. Relay Protection and Control of the 138-Kv Underwater Cable Tie between Vancouver and the British Columbia Mainland. *S. B. Wilkinson*, Canadian Westinghouse Co., Ltd., *A. Rohrmayer*, B. C. Engineering Co.

57-671. Analysis of Simultaneous Line-to-Ground Faults. *G. I. Stillman*, Public Service Electric & Gas Co.

CP57-672. Economic Comparison of Switched Capacitors and Voltage Regulators for System Voltage Control. *W. S. Ku*, Public Service Electric & Gas Co.

9:00 a.m. Industrial Power Systems

CP57-639. Economic Evaluation of Industrial Power System Reliability. *W. H. Dickinson*, Esso Research & Engineering Co.

CP57-640. Industrial Application of High Frequency Power. *V. C. Geckler*, New Departure Division General Motors Corporation

CP57-641. A Report on the Use of D-C Overpotential Testing in Industrial Power Systems. *Victor Wouk*, Beta Electric, Division of Sorensen & Company, Inc.

57-304. Locating Surge Arrestors and Capacitors for Rotating Machine Protection on Industrial Power Systems. *A. H. Knable, D. Dalasta*, Allis-Chalmers Mfg. Co.

9:00 a.m. Insulated Conductors

CP.* Dielectric Strength of Cable Insulations. *A. H. Shepherd, P. H. Ware*

CP.* Aerial Cable Installation Practice and Service Experience. *W. A. Thue*

CP.* Lightning Performance of Aerial Cables—Field and Laboratory Studies. *W. A. Thue, J. M. Clayton*

57-736. Surge Performance and Protection of Aerial Cable. *H. R. Armstrong, R. T. Curto*, The Detroit Edison Co.

57-737. Surge Performance of Aerial Cable, Part I—Surge Testing of the Aerial Cable and Analysis of the Test Oscillograms. *A. J. Schultz, F. C. Van Wormer, A. R. Lee*, General Electric Company

57-738. Surge Performance of Aerial Cable, Part II—Mathematical Analysis of the Cable Circuits and Synthesis of the Test Oscillograms. *F. C. Van Wormer, A. J. Schultz, A. R. Lee*, General Electric Company

9:00 a.m. Management

CP.* Economic Implications of Automation. *J. J. Brown*, Industrial Automation, Ltd.

2:00 p.m. Wire Communications

2:00 p.m. Transformers

57-749. Current Transformer Error Calculations. *N. A. Hills*, Moloney Electric Company of Canada, Ltd.

57-119. Cascade Potential Transformers. *G. Camilli*, General Electric Company, *H. R. Lucas*, Canadian General Electric Company, *L. W. Marks, C. H. Tuttle*, General Electric Company

57-750. Loading of Ventilated Dry-Type Transformers. *L. C. Whitman*, General Electric Company

57-117. Transformer Noise Problem—Performance of Acoustic Treatments and Vibration Isolators. *A. T. Edwards*, Hydro-Electric Power Commission of Ontario

CP57-751. Emergency Loading of Power Transformers. *J. B. Hodtum*, Allis-Chalmers Manufacturing Company

2:00 p.m. Research

CP.* Research in Canada for the Power Industry. *B. G. Ballard*

CP.* Research Projects of the Electric Utility Industry. *H. P. Seelye*

CP57-712. Progress in Power Apparatus. *F. J. Vogel*, Allis-Chalmers Manufacturing Company

CP.* Electrical Energy and Extractive Metallurgy. *L. M. Pidgeon*

2:00 p.m. Special Instruments and Auxiliary Apparatus

57-648. Measurement of Voltage Ratio at Audio Frenquencies. *W. C. Sze*, National Bureau of Standards

57-662. A 14-Channel Displacement Measuring Device Utilizing Magnetic and Paper Tape Recording. *G. R. Partridge*, Raytheon Manufacturing Company, *J. W. Dunkin, R. L. Anderson, R. C. Geldmacher*, Purdue University

57-353. The Response of Resistance Voltage Dividers to Steep Front Impulse Waves. *A. F. Rohlfs, J. S. Kresge, F. A. Fisher*, General Electric Company

CP57-663. A Voltage-Limited Capacitance Divider. *L. L. Alston, J. M. Russell*, The Royal Technical College

2:00 p.m. Computing Devices and System Engineering

57-680. Electric Analog Circuits for Exact Economic Dispatch. *R. Bruce Shipley*, Consulting Engineer, Chattanooga, Tenn.

57-681. Automatic Calculation of Load Flows. *A. F. Glimn*, General Electric Company, *G. W. Stagg*, American Gas and Electric Service Corporation

57-682. Nodal Iterative Solution of Power Flow Problem Using IBM 604 Digital Computer. *Donald McGillis*, Quebec Hydro-Electric Commission

57-683. Digital Computation of Induction Motor Transient Stability. *J. L. Gabbard, J. E. Rowe*, Union Carbide Nuclear Company

2:00 p.m. Industrial Power Systems

CP57-642. The Tie between a Utility and an Industrial when the Industrial Has Generation. *D. V. Fawcett*, Canadian Westinghouse Company, Ltd.

CP.* Power Distribution at Powell River. *O. M. Julson*, Powell River Company, Ltd.

CP57-644. Power Distribution and Protective Features in the Mannesmann Tube Mill. *E. J. Bartley, A. Ketvirtis, I. S. Cooper*, Foundation of Canada Enginering Corporation, Ltd.

CP57-645. Equations for the Inductances and Current Distribution of Multiple-Conductor Single-Phase and Polyphase Busses. *T. H. Chin*, University of Pittsburgh, *T. J. Higgins*, University of Wisconsin

CP57-646. Equations for Evaluating Short-Circuit Forces on Multiple-Strap Single-Phase and Polyphase Busses for Supplying Low Frequency Induction Furnaces. *T. H. Chin*, University of Pittsburgh, *T. J. Higgins*, University of Wisconsin

56-767. A Transient Stability and Voltage Study for a Modern Oil Refinery Distribution System. *C. W. Boice*, C. F. Braun and Company; *S. R. Durand, D. Dalasta*, Allis-Chalmers Manufacturing Company (Re-presented for discussion only)

2:00 p.m. Insulated Conductors

57-739. BPA High Voltage Cable Studies. *R. J. Mather, F. J. McCanna, E. Demirjian*, Bonneville Power Administration

57-740. Past and Present Practice and Experience on High Voltage Underground Cable Systems in France. *R. A. Tellier*, Electricite de France

CP.* St. Lawrence River High Voltage Submarine Cable Crossing. *D. M. Farnham, S. Cunha, G. B. Shanklin, H. D. Short*

2:00 p.m. Power Generation

57-686. Antifriction Bearings for Kaplan Hubs. *G. T. Abernathy*, Newport News Shipbuilding and Dry Dock Company

CP57-687. Vertical Waterwheel Turbine Clearance Adjustment through the Controlled De-

flection of Generator Thrust Bearing Supports. *D. K. Venus, C. C. Sargeant,* Canadian Westinghouse Company, Ltd.

CP57-688. Low Cost Power House Vertical Waterwheel Generators. *D. R. Ritcey, C. C. Sargeant,* Canadian Westinghouse Company, Ltd.

CP57-689. The Evolution of the Modern Waterwheel Generator in Canada. *G. D. Floyd, H. R. Sills,* Canadian General Electric Company, Ltd.

Friday, June 28

9:00 a.m. Transformers

57-752. Extremal Area Effect for Large Area Electrodes for the Electric Breakdown of Transformer Oil. *K. H. Weber, H. S. Endicott,* General Electric Company

CP57-753. Transformer Oil Preservation. *J. R. Meador, N. E. Dillow,* General Electric Company

CP.* An Improved Method of Oil Preservation and Its Effect on Gas Evolution. *R. J. Ringlee, W. J. Degnan, G. G. Doucette*

57-636. Corona Measurements on Oil Insulated Transformers. *E. J. Adolphson, F. J. Vogel,* Allis-Chalmers Manufacturing Company

CP57-754. The Use of Neutral Current Measurements during Chopped Wave Impulse Tests on Transformers. *G. W. Lengnick, S. L. Foster,* Allis-Chalmers Manufacturing Company

9:00 a.m. Industrial Control

CP.* An All-Electric Automatic Control System for Maximizing Flow through a Multiple Station Pipeline. *B. Ewers,* Phillips Petroleum Company; *H. B. Rath,* Leeds and Northrup Company

CP57-702. The Testing of HRC Current Limiting High Voltage Fuses. *S. M. Prout,* Canadian Controllers Ltd.

CP57-703. A Digital Flying Extensometer for Temper Rolling Mills. *N. S. Wells,* The Steel Company of Canada, Ltd.

CP57-704. Adjustable Speed Control of A-C Motor Drives for Movable Traffic Bridges. *H. J. Crawford, W. D. Duerksen, J. C. Orr,* Canadian Westinghouse Company, Ltd.

CP.* Adjustable Voltage Travelling Bucket Cranes. *E. A. Horsley,* Provincial Engineering, Ltd.

9:00 a.m. Rotating Machinery

57-758. Low Frequency Performance of a Wound Rotor Induction Motor for Mine Hoist Drives. *G. L. Tiley, F. F. Dixon,* Canadian Westinghouse Company, Ltd.

57-759. A Low Frequency Generator and Frequency Changer for A-C Mine Hoist Drives. *C. W. Elliot, W. Boesel, E. Zucker,* Canadian Westinghouse Company, Ltd.

CP57-760. Analysis of D-C Rotating Machines as Two-Port Networks—I. *V. C. Rideout,* The University of Wisconsin

CP57-761. Analysis of D-C Rotating Machines as Two-Port Networks—II. *W. B. Swift,* The University of Wisconsin

9:00 a.m. Computing Devices

CP57-790. Dynamic Response of Flight Tables. *F. T. Nicholson,* University of Pennsylvania

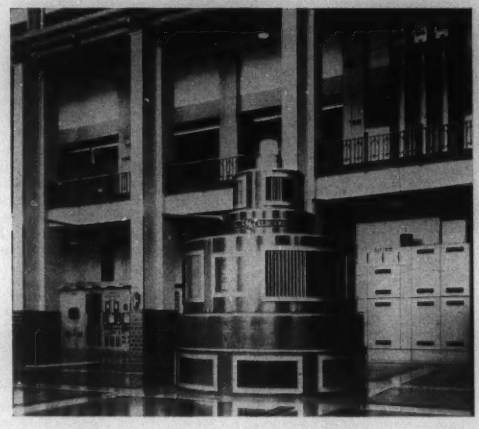
CP57-701. Spectrum Analysis of Random Noise Generators. *L. G. Polimerou,* Convair

CP.* An Integrated Analog-Digital Technique for Investigation of Dynamic Systems. *H. G. Lustig,* Boeing Airplane Company

CP57-661. The Generation of Functions for Analog Computers. *P. E. Stanley,* Purdue University

9:00 a.m. System Engineering and Power Generation

57-691. A Simplified Basis for Applying Probability Methods to the Determination of Installed Generating Capacity Requirements. *C. W. Watchorn,* Pennsylvania Power and Light Company



ONE OF THE TWELVE 55,000-hp turbines inside Section No. 2 at the Beauharnois Power Plant. Section No. 1 is equipped with 14 Francis-type 53,000-hp turbines. An inspection trip to the power plant will be held during the Summer General Meeting.

57-692. Use of Probability Methods in the Economic Justification of Interconnecting Facilities between Power Systems in South Texas. *A. P. Jones,* Central Power and Light Company, *A. G. Mierow,* Central and Southwest Operating Committee

57-693. Control of Reactive Kva with Modern Amplidyne Voltage Regulators. *A. S. Rubenstein, W. W. Walkley,* General Electric Company

CP.* Selecting Criteria for Transient Stability in Power System Planning. *B. L. Lloyd, C. A. DeSalvo,* Westinghouse Electric Corporation

9:00 a.m. Transmission and Distribution

9:00 a.m. Radio and Television Broadcasting

57-659. The Canadian Broadcasting Corporation's Radio Service in Canada. *N. R. Olding,* Canadian Broadcasting Corporation

57-665. The Development of Television in Canada. *J. E. Hayes,* Canadian Broadcasting Corporation

CP57-666. Video Testing Techniques in Television Broadcasting. *A. Ste. Marie,* P. O. Box 10, Snowdon, Montreal, Que.

CP.* Current Practices in TV Lighting and TV Lighting Controls. *Herbert More,* Kliegl Bros., Universal Electric Stage Lighting Company, Inc.

9:00 a.m. Basic Sciences

CP57-745. Subharmonics in Iron-Cored Reactor Oscillatory Circuits. *A. E. Mostafa, M. I. El-Karaksi,* Alexandria University, Egypt (by title only)

CP57-746. Electric Nonlinear Computation Performed by Linear Elements. *M. S. M. Abou-Hussein,* University of Cairo, Egypt (by title only)

CP57-747. Instantaneous Resistance Analysis Method of Network Analysis. *Ira Ritow,* Republic Aviation Corporation

CP57-748. Constant Resistance Networks to the Aid of Network Synthesis. *Dov Hazony,* Electro Measurements Inc.

CP.* On the Order of the Differential Equation Describing an R-L-C Network. *J. Otterman,* University of Michigan

2:00 p.m. Transformers

57-632. An Electronic Electrometer as a Versatile Corona Detector. *J. G. Anderson, J. S. Kresge,* General Electric Co.

57-755. Magnetic Amplifier Control for Load Tap Changing Equipment. *Bryan Webb, Jr., G. D. Throop,* Westinghouse Electric Corporation.

CP57-756. Analysis of Three-Limb Transformer Cores and a New Instrument for Measurement of Exciting Current Waveforms. *J. K. Delson,* General Electric Co.

57-757. Excitation Requirements of Three-Phase, Core-Type, Three-Legged Wye-Connected Transformers. *C. S. Walker,* Oak Ridge National Laboratory

2:00 p.m. Rotating Machinery

57-762. Predicting Insulation Failures with Direct Voltage. *C. M. Foust, B. V. Bhimani,* General Electric Company

CP.* Insulation Evaluation for Medium Size Machines Using Form-Wound Motorettes. *G. L. Moses*

57-763. Permanent Magnet Generators—Part I —Theory. *D. J. Hanrahan, D. S. Toffolo,* U. S. Naval Research Laboratory

CP57-764. A New Device Ensuring Operating Reliability of Large Constant Gap Generators in Underexcited Conditions. *Francois Cahen, B. Favez,* Electricite de France

2:00 p.m. Computing Devices

CP.* The Power Control Simulator. *R. W. Kettlety,* General Electric Company

CP.* An Automatic A-C Network Analyzer Load Control Unit. *J. J. Gravel,* General Electric Company

57-684. Analog Computer Study of the Transient Performance of a Dual Cycle Boiling Water Reactor Nuclear Power Plant. *D. W. Leiby,* General Electric Company

57-685. A Rolling Mill Analog for the Study of Nonlinear Problems Associated with Gauge Control. *L. R. Hulls, K. R. Canfor,* Canadian Westinghouse Company, Ltd.

2:00 p.m. Transmission and Distribution

2:00 p.m. Power Generation

57-694. Integration of Hydro and Thermal Power Resources in Alberta. *M. M. Williams,* Calgary Power Ltd.

CP57-695. The Bersimis—LAC CASSE 1¼ Million Hp Development. *H. F. Abbott,* Quebec Hydro-Electric Commission

57-653. The Electrical Features of the St. Lawrence Power Project. *John Saloma,* Charles T. Main, Inc.

2:00 p.m. Hagerstown Education Television Project

CP57-667. Pioneering in Televised Education. *J. R. Brugger,* Board of Education, Hagerstown, Md.

CP.* Establishing and Equipping the Hagerstown Educational Television Project. *L. L. Lewis,* Radio Corporation of America

57-668. Closed-Circuit Network for Educational Television. *W. C. Warman,* The Chesapeake and Potomac Telephone Company

CP57-669. Television Systems for In-School Teaching. *M. H. Kraus,* Jerrold Electronics Corporation

(Continued from page 517)

the largest transformers in the world have been installed. The Bout de l'Ile Station is the terminal of Bersimis-generated power.

Summer General Meeting Committee

Members of the 1957 Summer General Meeting Committee are: F. L. Lawton, chairman; W. R. Wray, vice-chairman; C. L. Roach, secretary; D. M. Farnham, treasurer; F. L. French, technical program co-ordinator; H. W. Haberl, entertainment co-ordinator; C. A. Wright, services co-ordinator; A. C. Abbott, Montreal Section representative. The Committee Chairmen are: W. R. Wray, finance; C. E. Wollgar, registration; T. F. Palmquist, meetings and papers; J. Lawrence, W. Schippel, students; H. W. Haberl, smoker; P. W. Howlett, hospitality; Mr. and Mrs. H. H. Remine, ladies; R. C. Short, sport; J. M. Sharpe, social; O. Francoeur, hotels and rooms; Leo Roy, publicity; W. R. Simons, information; J. D. Sylvester, transportation.

Annual Meeting

The annual meeting of the American Institute of Electrical Engineers will be held in Montreal, Que., Canada, at 2:00 p.m., Monday, June 24, 1957, during the Summer General Meeting.

At this meeting, the annual report of the Board of Directors and the reports of the Committee of Tellers on the ballots cast for the election of officers and for the proposed amendments to the AIEE Constitution will be presented. The Lamme Medal will be presented to Harold H. Beverage (AM '23, M '34, F '48).

Such other business, if any, as may properly come before the annual meeting may be considered.

Signed N. S. Hibshman
Secretary

AIEE Great Lakes District Holds Meeting in Des Moines, Iowa

SOME 400 ENGINEERS, scientists, educators, and industrialists met in Des Moines, Iowa, for the AIEE Great Lakes District Meeting, held April 15-17, 1957 at the Hotel Fort Des Moines. The District includes the states of Iowa, North Dakota, South Dakota, Minnesota, Michigan, Illinois, and Indiana.

In addition to the technical program, during which 32 papers were presented, several other events were planned by a committee headed by K. R. Brown, general chairman. A number of inspection trips were made, including tours of the Iowa Power & Light Company Systems Operating Center, the Maytag Manufacturing Company's Newton plant, the Institute for Atomic Research at Iowa State College in Ames, and the Firestone Tire & Rubber Co. Des Moines plant.

Student Paper Contest

Another feature of the meeting was the District Student Paper Contest. On Monday, 18 papers were presented by students from colleges and universities in the District. The first prize, $24, a certificate, and an expense-free trip to the AIEE Summer General Meeting in Montreal, Que., Canada, was won by James Foley of the University of Minnesota for his paper "An Investigation of the 'S' Generator Metadyne as a Generator Exciter." Second prize, $24 and a certificate, was awarded to J. L. LeMay of the University of Detroit. Third prize, $15 and a certificate, went to J. L. Neese of Iowa State College. Fourth prize was shared by C. R. Allen of the University of Illinois and R. J. Boyle of Marquette University. Honorable mention, with prizes of $10 each from funds supplied by the Great Lakes District, were awarded to the following: G. C. Vandling, Illinois Institute of Technology; C. N. Armstrong, Michigan State University; Eric Ziemer, Milwaukee School of Engineering; D. R. Smith, University of North Dakota; D. A. Calahan, University of Notre Dame; and J. P. Vogel, South Dakota State College.

Courtesy Des Moines Register and Tribune

SOME OF THE STUDENTS participating in the Great Lakes District Student Paper Contest were: (left to right) James Foley, first prize winner; Ralph Rothfusz; C. R. Allen, fourth prize co-winner; R. E. Onley; J. L. Neese, third prize winner; and J. L. LeMay, second prize winner.

General Session

District Vice-President J. H. Foote presided at the general session held Monday morning. He introduced Governor Herschel Loveless, who extended a welcome to the assembly. AIEE Secretary N. S. Hibshman presented the highlights of the Board of Directors meeting held at Jackson, Miss., during the AIEE Southern District Meeting, April 3-5, 1957. The principal speaker at the session was AIEE President M. S. Coover. The text of his address may be found on p. 524 of this issue.

Luncheon

A joint luncheon with the student members was held immediately following the general session. R. D. Strum of Rose Polytechnic Institute presided. An address, "Training the Engineer of the Future" was presented by J. F. D. Smith, dean of the Division of Engineering, Iowa State College. He stated that ". . . the engineer of the future should be better trained technically than at present, largely by acquiring more basic knowledge of engineering, leaving the applied [knowledge] until he goes through what would amount to an internship in industry." He further asserted, "At the completion of this internship . . . he should have acquired the breadth of view necessary for a professional man, and have been completely indoctrinated with the Ethics of the Profession, in a manner similar to the doctor."

Technical Sessions

Power System Stability. C. C. Doerrie of the Westinghouse Electric Corporation presided at a Monday afternoon session on power system stability. W. G. Kaldenberg of Iowa Power & Light Company presented the first paper, an analysis of the limits on generator operation due to overexcitation. Typical stability and power capability curves were shown.

"Use of Phase Space in Transient Stability Studies" by S. T. Bow of the Chinese Academy of Science and J. E. Van Ness of Northwestern University presents methods which

should be valuable in the analysis of third-order nonlinear systems. Some of the techniques that originated in control system work are extended to the analysis of a power system's stability. Two examples are given to illustrate the method presented.

A paper by A. A. Fouad, Ein-Shams University, Cairo, Egypt, and W. B. Boast, Iowa State College, gives the theory and method of development of a set of universal swing curves for a two-machine system, including a range of initial velocities. An array of 65 families of angle-time curves and an equal number of families of velocity-time curves are required to cover the range of the variables needed to solve practical two-machine systems. The paper presents a selected few of these illustrations to demonstrate the principles involved and the application of the curves to the solution of practical problems.

Distribution. A Tuesday morning session on distribution opened with a paper by Yale Goldberg and G. L. Walkup of Iowa Power & Light Company, covering many of the problems encountered in network conversion in Des Moines. At the present time, Iowa Power & Light is installing underground facilities required for the cutover of three underground network vaults to 13.8-kv operation. Conversion of approximately one half of the present 4-kv network system is proposed.

"Estimating Kw Demand for Future Loads on Rural Distribution Systems" by S. J. Vest of the Rural Electrification Administration describes a new method for determining kw demand by the multiplication of two factors corresponding to the number of consumers and kwh usage. These factors may be read from tables or determined mathematically. The paper outlines the history of the demand curves, the techniques used in preparing the latest information, and the manner in which the curves and tables are used.

R. W. Meisner of the Commonwealth Edison Company, Chicago, Ill., described the determination of maximum permissible voltage fluctuation caused by ¾-ton 115-volt air-conditioning units. An analysis of the effects of room-cooler operation on service voltage at a customer's outlet, served from the present 4-kv distribution transformer system was conducted, as well as a review of present and past appliance load characteristics.

Controls and Control Systems. The session, held Tuesday afternoon, opened with a paper on speed control of a prime mover by G. F. Drake of the Woodward Governor Company, Rockford, Ill. The paper primarily is concerned with the effects of engine and load characteristics on speed governors, as well as means for securing system stability.

C. L. Townsend of Iowa State College described a root-locus method for compensating a system containing a pair of conjugate complex poles. The method considered is that of utilizing a compensation network having a transfer function from which a pair of conjugate complex zeros is obtained. The zeros of the compensation network are placed at specified points in the S-plane and the closed-loop system response is determined.

The next paper presented was "Quasi-Optimization of Relay Servos by Use of Discontinuous Damping" by W. L. Harris, Jr., C. McDonald, and G. J. Thaler, all of the U. S. Naval Postgraduate School, Monterey, Calif. The paper discusses a method which has been developed for using discontinuous damping to obtain a relay servo which has a deadbeat response to a step input.

In the final paper of the session, E. H. Preston of the Leeds & Northrup Company described features of automatic control of electric power generation.

Transmission. The first paper presented at the session on transmission, held Wednesday morning, was "Transmission System Voltages Under Single and Double Line-to-Ground Fault Conditions" by R. W. Johnston of the Iowa Public Service Company. The higher of the two overvoltages which result from a single line-to-ground fault is the generally accepted criterion used in the selection of lightning arresters. In this paper, a method is developed whereby, for various circuit parameters, circle diagrams can be constructed from which both these overvoltages can be determined graphically from the same chart both in magnitude and in phase angle. Both single and double line-to-ground faults are treated.

J. W. Nilsson of Iowa State College presented a paper entitled "Some Observations on the Flow of Real and Reactive Power on a Transmission Line." The observations made were based on the analysis of equations for real and reactive power at the terminals of a transmission line.

"Rating of Autotransformers for System Interconnection" by E. T. B. Gross of Armour Research Foundation and J. C. Pohlman of Hubbard and Company presents a systematic means for calculating these ratings semigraphically. This method is easy to manipulate, general in nature, and shows the effect of variations of operating conditions on the transformer design.

S. W. Anderson of the Middle West Service Company presented the final paper of the session, which describes an investigation on the unbalanced loading of 3-phase transformer banks.

M. S. COOVER (*center*), AIEE president, and J. H. Foote (*right*), vice-president of AIEE Great Lakes District, congratulate K. R. Brown (*left*), general chairman of the Great Lakes District Meeting, on the success of the meeting.

Courtesy Des Moines Register and Tribune

Courtesy Des Moines Register and Tribune

AT THE SPEAKERS' TABLE during the opening general session of the Great Lakes District Meeting were: (*left to right*) K. R. Brown, general chairman; Governor Herschel Loveless, who welcomed the visiting engineers; J. H. Foote, vice-president of the Great Lakes District; M. S. Coover, AIEE president; and N. S. Hibshman, Institute secretary.

Interdependence in the Life of the Professional Engineer

M. S. COOVER,
PRESIDENT, AIEE

I AM DEEPLY MOVED to be appearing before you at this Great Lakes District Meeting not only as a member of the Iowa Section of the American Institute of Electrical Engineers but also as President of the great professional engineering organization that we are representing. However, mingled with that feeling is one of pride that our Iowa Section is privileged to serve as host again to a District Meeting of the Institute, for it portrays the kind of vigorous sponsorship that permeates our total membership. It represents an opportunity to bring a segment of the Institute to Iowa for the second time in recent years and the responsibility to invest some time and energy in our chosen profession. It represents an opportunity to keep AIEE members and others abreast of new developments in technology and the responsibility for bringing encouragement to younger engineers into whose hands new techniques begin to reside more universally by reason of their more rigorous and advanced technical training. In short it represents complete interdependence.

Romance in Engineering

Some electrical engineering students are here at the meeting. I wish it were possible for more of them to be present, for I want to say to all of them that there is no place in the space beyond space where the remotest idea could have been generated for me as a member of the Student Branch of AIEE at my Alma Mater that some day I would be honored with the presidency of the American Institute of Electrical Engineers. The one fact, however, that was clear in my mind at that time was that since I had chosen my profession with a determination to pursue it, there were advantages to be gained through positive identification and association whenever it was possible to do so with those in the Institute. Stimulation came through attendance at Student Branch Meetings, and for a short time following graduation while employed in the New York metropolitan area, every opportunity was used to attend meetings of the New York Section. Those opportunities were the clinching ones for me. I heard and saw many of the leaders in the electrical engineering profession in action. It was electrical engineering, henceforth, come what may. As I look back now, it was almost akin to the statement accredited to someone who, in debating a policy to pursue, said "come weel or come woe, my status is quo." Anyway, those occasions in New York prompted a deepening interest and an added stimulus. Those men seemed to be engulfed in what could be characterized as romance in engineering. Those electrical engineers appeared to hold promise of all the romance in engineering that anyone would be capable of embracing. Their enthusiasm was contagious. To me, they were helping to make electrical engineering history. The truth is that for me electrical engineering seemed to stand out as the most glamorous profession on earth. Out of that experience has grown the life-long hope that every young person could, at some time in their early years, have the same kind of deep-seated feeling and conviction and satisfaction over his or her choice of occupation or profession.

Whoever said that there is permanent glamour in engineering most certainly pronounced a truism. The mark of the engineer is on everything that makes for better living. We are living in an age that is predominantly scientific. Most of you made the choice of engineering as a profession and probably most of you chose electrical engineering. It happens to be the fastest growing and most rapidly expanding of all. Be that as it may, we can be successful only when we are happy in what we are doing. Let us be forever grateful that we in America have the privilege of making our own choice of vocation.

Continuing to address my remarks for the moment to the younger folks, it is by no means a matter of coincidence that the American Institute of Electrical Engineers is predominantly a leader in the entire electrical engineering field. The AIEE has an understandable interest in encouraging students of electrical engineering and electrical engineering graduates who are developing their careers to look objectively at the pattern of their progress, to look to the American Institute of Electrical Engineers for its broad offerings, and to consider the possible disadvantages of becoming too highly specialized too early in life. There is nothing obscure or indefinite about the position of the Institute among organizations that in their own right represent the engineering profession.

The Institute constantly needs new blood and new ideas. New members can furnish both. It works both ways, for unless the atmosphere is such that the membership has a need for the Institute, the curve will bend in the wrong direction. Institute meetings at all levels throughout each year can mean much to those who participate in them, and you will observe that those who do participate are found to be in that group frequently spoken of as "making good." If each and every member will give an ever increasing measure of support to the Institute, there is reasonably safe guarantee that he will reap much personal satisfaction out of that giving no matter what form it takes.

Someone said "the history of any profession is written in the lives of the men who create it." Any one of you can name men who helped make history for the electrical engineering profession whether you know them, have known them, or know of them only through their record of achievements. I have the greatest respect and admiration for everyone of them, some of whom it has been my privilege to know personally. The nature and scope of accomplishments and contributions to the art by any one person varies but, nevertheless, he does his part in writing the historical record of the profession.

"The Second Mile"

Among those whom I have been privileged to know personally and one who is remembered affectionaly and with admiration by all is AIEE Past-President W. E. Wickenden. Those who did know him will agree that Dr. Wickenden wrote fluently and spoke fluently with force and meaning. He was devoted to everything that claimed his time and interest. If you have never read his address "The Second Mile" I commend it without hesitation to your reading. For those who may be unfamiliar with it, permit me to offer a few lines. He opens with the familiar quotation "Whosoever shall compel thee to go one mile—go with him twain." Then he goes on to say, and I quote,

> "I am not sure that I should dare to choose this as a text for a talk to engineers, such is the present state of our biblical illiteracy. However you will recognize it from the Sermon on the Mount as a counsel of perfection, good advice in the form of a paradox which emphasizes a profound truth by an apparent denial of common sense."

But "A text is like a gate, it has two uses; you can either swing on it, or you can open it and pass through. Let us pass on through."

Continuing, he says,

> "Every calling has its mile of compulsion, its daily round of tasks and duties, its standard of honest craftsmanship, its code of man-to-man relations, which one must cover if he is to survive. Beyond that lies the mile of voluntary effort, where men strive for excellence, give unrequited service to the common good, and seek to invest their work with a wide and enduring significance. It is only in this second mile that a calling may attain to the dignity and the distinction of a profession."

Dr. Wickenden goes on to point out that engineers need to develop a professional consciousness. "Many men," says he, "who call themselves engineers and who have proved themselves competent in accepted technical practices, have not attained a real professional stature."

Personally, I doubt if an occasionally quiet moment devoted to self analysis or to self appraisal, or to a careful systematic attempt to understand and evaluate ones own progress ever has had adverse influences. If the individual is honest with himself he will conclude that either he is still on his first mile or that he is moving into and may

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Essentially full text of a speech delivered at the AIEE Great Lakes District Meeting, Des Moines, Iowa, April 15-17, 1957.

M. S. Coover is administrative assistant, Division of Engineering, Iowa State College, Ames, Iowa.

be progressing satisfactorily on his second mile.

As time goes on, the duties of the successful engineer are bound to change, either slowly or rapidly. Sometimes new assignments are not too closely related to previous ones either in kind or geographic location. Generally, they bear heavier responsibilities to his employer, to his employer's customers, and to the community. He probably has been recognized not only as an engineer, but also as an upright citizen with concern over social attitudes and public policies. Most likely he has shown an awareness that science and research are essential to the continued existence of his company's business and that they are interwoven with the cultural forces of education, religion, Government, industrial relations, politics, and communications. Furthermore, it is highly probable that he is being careful not to overlook moral, ethical, and spiritual values. Surely he is the one who can be said to be traveling his second mile.

Society Depends on Engineers

Never before in all history has society become more conscious of its dependence upon scientists and engineers. Industry depends upon them for a steady stream of new and diversified products so that business continues to be both the main spring and the balance wheel of our economy. Society depends upon engineers for national survival through their ingenuity to develop, produce, and deliver instruments of destruction if need be. Engineers thus have become a commodity in short supply in some areas. Perhaps it can be stated quite fairly that they have become the aristocracy of necessity. But let us not allow ourselves to be disillusioned by this sudden dependency.

Most, if not all, of the experiences that broaden and enrich our lives come to us after college years. True education always will remain an individual achievement. Floating along with life, being content to assimilate only ordinary everyday circumstances is like a piece of wood floating along with the current, going only where the current takes it, or depositing it in a slough. Self-direction, although sometimes difficult, is creative and can lead to cherished rewards.

The skills and the ability of the engineer touch all human existence more closely with each passing year. As a result, the scale of our lives is constantly shrinking and the pattern of our lives is being reshaped for better living. By the very nature of his training, the engineer is expected to think clearly and vigorously, and to approach his assignments with a disciplined mind. We realize that an extremely high degree of specialization is essential in some areas. However, this same rigorous type of training on the part of the engineer also can be a precious asset to society if there is a disposition to take an active interest in civic affairs with a willingness to weigh evidence dispassionately, free from fears and prejudices. This type of interdependence can lead to the development of successful professional citizenship as well as successful professional engineering.

Board of Directors Meeting Held Held in Jackson, Miss., April 5, 1957

THE BOARD OF DIRECTORS met at the Heidelberg Hotel in Jackson, Miss., on April 5, 1957, during the Southern District (No. 4) Meeting. Twenty-three Board Members and five Department Chairmen were present.

Budget

The budget for the fiscal year 1957-58 was approved. The anticipated income is $1,824,600; less than half of which will come from dues and fees of all kinds paid by members of all grades.

Treasurer's Report

The Treasurer's report showed a balance in the General Fund as of February 28, 1957, of $252,579.52 compared with $321,922.30 at the same time last year. The total Section appropriation was paid in October of this fiscal year. Last year, only half had been paid before March 1. This accounts for about $40,000 of the difference.

Annual Meeting

The Board approved and recommended favorable action by the membership, at the Annual Meeting on June 24, 1957, in Montreal, Que., Canada, on amendments to the New York State Certificate of Incorporation intended to clarify the statement of the Institute's purposes, and to raise the limit on the maximum number of members of the Board of Directors. The revised statement of purpose is to delete certain terms, the connotation of which has changed in common usage since the original drafting of the certificate in 1896. Anticipated further increase in the number of Districts requires the raising of the permissible number of members of the Board. The resolutions to be voted on at the Annual Meeting are printed in this issue of *Electrical Engineering* on page 528.

Division of District No. 4

The Southern District (No. 4) announced that its Executive Committee had voted on April 2, 1957, to divide into two Districts of very nearly equal size. Five Atlantic Seaboard States will constitute one District and the five states composing the western half of District No. 4 will be the other. A committee has been appointed to draw up a detailed plan for approval at the District No. 4 Executive Committee Meeting in the fall of 1957. The division, if approved by the Board of Directors, is to become effective August 1, 1958.

Intersociety Relations

Approval was voted of a policy on "Intersociety relations" which had been under consideration since the Board Meeting in San Francisco, Calif., in June of 1956. The AIEE position is stated in President Coover's letter to the members of AIEE, in this issue of *Electrical Engineering* on page 516.

United Engineering Center

The Board heard a report on the progress of the new United Engineering Center from W. J. Barrett, president of United Engineering Trustees. The use of the present site on 39th Street has been found impractical. A new site is being sought in accordance with the Task Committee plan approved by the Five Societies. A building fund is to be raised by appeals to industry and to the members of the Five Societies. The Board of Directors of AIEE voted approval of a proposed solicitation of the Institute members for contributions to the United Engineering Center Building Fund.

New Members and Transfers

Eight members were elected to the grade of Fellow. Announcement with individual biographical sketches will appear in an early issue of *Electrical Engineering*. Other additions to the membership, since the January meeting of the Board, were: 122 Members, 402 Associate Members, 77 Affiliates, 541 Student Associates, and 44 Student Affiliates.

Kettering Award

Approval was given by formal vote to the "Rules of Award" of the Charles Franklin Kettering Award which is jointly sponsored by AIEE, American Society of Mechanical Engineers, American Society of Civil Engineers, American Institute of Mining, Metallurgical and Petroleum Engineers, American Institute of Chemical Engineers, and Society of Automotive Engineers.

Appointments

The following appointments were made or approved by the Board at this meeting: C. H. Linder to be a Director, August 1, 1957, to July 31, 1958, to fill an unexpired term to be vacated by the present nominee for Treasurer, L. F. Hickernell; E. W. Engstrom to a six-year term on the Hoover Medal Committee, effective May 1, 1957; R. D. Maxson to a two-year term on the Washington Award Commission; the following to be Tellers for the 1957 election: D. C. Aker, W. H. Bliss, C. R. Boytano, Nicholas Davis (chairman), E. W. DuBois, H. M. Evans, W. W. Holloway, W. A. Ock, J. A. Reifenberger and H. A. Schumacher.

Student Branches Committee

It was voted to approve in principle the transfer of the Student Branches Committee

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CORRECTION: On page 392 of the May issue of *Electrical Engineering*, the first equation in col. 2 should read:

$$G =]1 + GDH]^{-1} GDR$$

The second equation in col. 2 should read:

$$C = \begin{bmatrix} P_a P_c \\ 0 \quad 1 \end{bmatrix}$$

from the Professional Development and Recognition Department to the Administration Department—Bylaw changes to be formally presented at the June Board Meeting. The reassignment of certain Representatives to other bodies will be studied by the Institute's Planning and Co-ordination Committee.

Institute Meetings

The following General and District Meeting dates were reported by the Technical Operations Department: 1960 Pacific General Meeting, San Diego, Calif., second week of August likely; 1961 Pacific General Meeting, Salt Lake City, Utah, August 23, 24, 25; 1962 Summer General Meeting, Denver, Colo., third week in June; 1962 Fall General Meeting, Chicago, Ill., no date set.

Board Meetings

The Board Meeting scheduled for Pasco, Wash., as a part of the 1957 Pacific General Meeting August 28-30, was cancelled. The Planning and Co-ordination Committee was asked to recommend a new pattern of Board meetings consistent with the Board's function in the new departmental form of organization. Greater use of the Executive Committee is anticipated.

The next meeting of the Board of Directors will be held in Montreal, Que., Canada, during the 1957 Summer General Meeting on Friday, June 28.

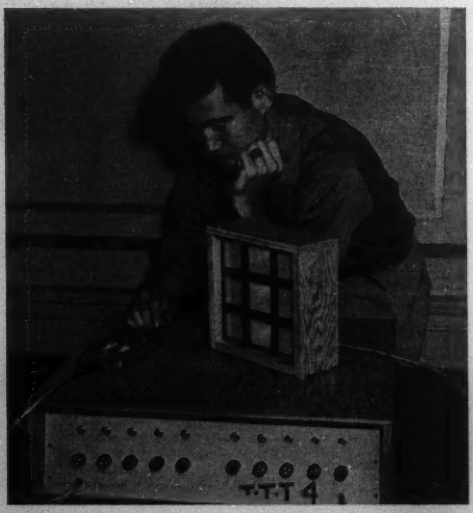
Jackson, Miss., Welcomes Engineers Attending Southern District Meeting

JACKSON, capital of Mississippi, extended a warm welcome to the 528 engineers, engineers' wives, and students attending the Southern District Meeting of the AIEE held April 3-5, 1957, at the Heidelberg Hotel. All of the states in the District—Kentucky, Tennessee, North Carolina, Mississippi, Alabama, Georgia, South Carolina, Louisiana, Virginia, and Florida—were well represented at the meeting.

General Session

R. D. Yarbrough of Southern Bell Telephone & Telegraph Company chaired the general session on Wednesday morning. In extemporaneous speeches of welcome flavored with southern folk humor, the Hon. Allen Thompson, mayor of Jackson, and the Hon. J. P. Coleman, governor of the State of Mississippi, quickly dispelled the strangeness characteristic of opening day general sessions.

J. O. Emmerich, editor of the *Enterprise Journal*, McComb, Miss., delivered the main speech. His theme was the technical gauntlet flung down by the USSR to the West, drawing on his experiences during a recent visit to that country. The Soviets single-mindedly are concentrating on the production of engineering cadres, realizing the vast importance of technological manpower in the cold war. He stressed the solicitude of the Soviet Government for its elementary school students who concentrate with grim diligence on their studies. Everything is done in long-range perspective, he emphasized, pointing to the huge area planted to corn last year, an area equal to the states of Mississippi and Louisiana combined. He warned the United States may find itself in the position of Great Britain who, despite Churchill's statement he "was not appointed the King's Minister to preside over the liquidation of the British Empire," sees her empire slowly melting away due to inexorable forces she cannot stay. The effect of his remarks was more disquieting than the seasonal tornadoes that passed within 30 miles of Jackson.



L. W. COTTEN, student at North Carolina State College, won first prize in the Southern District Meeting Student Paper Contest for his paper "The Link-Circuit Computer."

Luncheon

At the luncheon which followed the general session, M. S. Coover, president of the AIEE, reviewed the reasons for the steady growth of the organization, emphasizing the sensitivity of the AIEE to the needs of its member engineers and the engineering profession in general. His speech is printed in *Electrical Engineering*, May 1957, p. 422.

Inspection Trips

There were a variety of interesting inspection trips that included visits to the Vickers Plant of the Century Mfg. Co., the Southern Bell Telephone Building, the Rex Brown Steam Electric Station, the Mississippi Products Corp., and the Armstrong Cork Co. For the ladies, there was a bridge and canasta luncheon, a coffee hour each morning, and a tour of historic Natchez to visit the mansions and gardens of the ante bellum era.

Student Paper Contest

Over 50 papers were read at the technical sessions. The technical sessions were enlivened by the District Student Papers Contest in which more than 200 students took part either as participants or spectators. The three student winners, who received their prizes at the Supper-Dance held Thursday evening, were: L. W. Cotton of North Carolina State College, whose paper, "The Link-Circuit Computer," received first prize consisting of an all-expense trip to the Summer General Meeting in Montreal, Que., Canada plus $25 cash award as well as an engraved certificate; J. W. Vaughan, Jr., of Duke University, who won the second prize; and R. A. English, of Georgia Institute of Technology, who won the third prize. Second and third prize winning students received a $25 cash award and an engraved certificate each.

Technical Sessions

Communications. The first technical session of the District Meeting featured a paper on "The Application of Negative Impedance Repeaters on Long Rural Telephone Lines," by H. T. Uthlaut, Jr., Southern Bell Telephone & Telegraph Company. With present-day expansion of telephone service into the rural areas at peak levels, transmission problems have arisen largely because of the inadequacy of the open wire circuits in present use. The present large demand, the author points out, dictates the use of cable facilities and requires the loops to extend to lengths unprecedented in normal exchange service. It is not unusual in present engineering of rural telephone service to encounter conductor loops well in excess of 100,000 feet from the serving telephone central office. When, as is so often the case, the demand is too small to establish a new central office economically and too great to allow open wire to be used, cable plant, with its resultant high attenuation, must be proposed.

F. E. Bates discussed "The Short Haul

MEETING HIGHLIGHTS

AIEE Southern District Meeting

Courtesy J. G. James

Courtesy J. G. James

Courtesy Hiatt Photo Service

STUDENTS REGISTER (top picture) for the AIEE Southern District Meeting held April 3-5, 1957, in Jackson, Miss. *Below, left:* At the coffee bar of the Heidelberg Hotel, are (*left to right*) T. R. Brock, chairman, inspection trips; C. A. Rogillio, treasurer; F. D. Joffrion, co-chairman, Student Committee; J. M. Hemphill, hotel arrangements; and R. E. Briggs, chairman, registration. *Below, right:* At the speakers table during the general session, are (*left to right*) Rev. W. F. Crouch, Jackson, Miss.; Hon. Allen Thompson, mayor of Jackson; Hon. J. P. Coleman, governor of the State of Mississippi; R. D. Yarbrough, general chairman; J. O. Emmerich, editor, *Enterprise Journal*, McComb, Miss.; M. S. Coover, President AIEE; and Prof. W. J. Miller, vice-president, AIEE District No. 4. Mr. Emmerich delivered the main address during the general session.

Telephone Carrier for Rural Service" as the logical answer to extension of telephone service to the rural areas of the United States. Although carriers used with land wire circuits are far from new, economics have dictated a different approach to the same idea. The author presented a typical telephone carrier with new innovations necessary for a solution of service problems for sparsely settled areas.

Computers. Under this general theme, principles of both analog and digital computers, and their applications and relationship to each other were discussed in four papers, the last of which was a panel discussion by all the authors that drew lively participation from the audience.

H. A. Owen, Jr., Duke University, covered the "Principles of Analog Computers" illustrating his talk with a laboratory model. B. W. Richardson, Western Electric Company, spoke on "An Application of Digital Techniques to Data Processing," and E. H. Tompkins, Jr., North Carolina State College, discussed "An Analog Application: The Computation of Rocket Flight," emphasizing the complex nature of the problems handled by the computer. V. S. Carson, also of North Carolina State, covered "Principles of Digital Computers." He described the digital computer as a glorified abacus, manipulating discrete bits of information by true arithmetic methods and providing answers in the form of digits. The computer also remembers numbers and the "memories" or data-storage elements are truly the components that set final limits on the precision of the answers.

Transformers. H. J. Mason, General Electric Company, in his paper "Progress in Power Transformer Development" described some of the major new developments in power transformers. Included was information on reduction insulation levels, new knowledge of gas evolution, a novel method of audible noise reduction, a discussion of the use of computers in design, a new type of high-voltage load-tap-changing equipment, and a description of new gas-insulated transformers.

W. T. Sackett's paper dealt with the "Effect of Manufacturing Processes on Dielectric Strength of Transformer Materials." Data was presented on the electrical strength of papers and wire insulations, using "ideal" test samples and test samples which are models of transformer coils. Both impulse and 60-cycle breakdown data were given and effects of drying, varnishing, and impregnating were shown. Test results on ideal samples showed poor correlation with results on model coils. Varnish impregnation, generally beneficial on paper sheets and twisted pair samples, was found to be detrimental to the electric strength of model coils.

Chemical Industry. The problem of inhibiting corrosion of any bared metal structure through the application of "cathodic protection" was discussed in papers by H. E. James, Mississippi Valley Gas Company, and O. J. Streever, Newport News Shipbuilding and Dry Dock Co. Mr. James dealt with the general aspects of the design and installation of impressed current ground beds in the light of the experience of the Mississippi Valley Gas Company. He pointed out that there are at least five considerations in locating a site for a ground bed: soil resistance, position with respect to pipe to be protected, position with respect to other underground metallic structures, availability of electric power, and protection from road or other type construction. The use of ground beds between 200 and 400 feet deep is becoming more common, and the installation of one of them is planned in the near future.

O. J. Streever discussed cathodic protection as applied to cellular type submergible-shipway bulkheads.

Power Generation. W. B. Wilson of the General Electric Company discussed the versatility of the gas turbine in his paper "Kilowatts and Horsepower—The Gas Turbine Does More." In addition to kilowatts and horsepower, steam, highly preheated combustion air, hot gas for various process or power used and compressed air are some

Courtesy T. G. James

ON A TOUR of the television center of the Southern Bell Telephone Company held during the Southern District Meeting were: (*left to right*) James Lancaster and Robert Baker, students at Tennessee Polytechnic Institute; C. L. Westling, American Telephone & Telegraph Company, Jackson, Miss.; and Glenn Russell, Tennessee Polytechnic Institute student.

of the additional outputs that the gas turbine can provide. The author provides examples to suggest ways the gas turbine can be utilized to reduce the cost of power and steam. Though some of the applications suggested are applicable in utility plants, this paper is devoted primarily to industrial and process applications.

Other papers presented at this afternoon session were "The Need for and Proposed Use of an Analog Computer in Steam Power Stations," by F. W. Shipley, Mississippi Power and Light Company, and "Utilization of Engineering Manpower in Large Reactor Design," E. S. Day, Jr., General Electric Company.

EMC and SMC Announce Activities Planned for 1957

The areas of activity of the Engineering Manpower Commission (EMC) of Engineers Joint Council and the Scientific Manpower Commission (SMC) for 1957 will be:

1. To promote better utilization of engineering and scientific manpower through co-operation with industry and Government. This will include promotion of the use of technical institute graduates and other supporting personnel in supplementing the work of graduate engineers.
2. To develop accurate statistics of supply and demand for engineering and scientific manpower.
3. To provide a clearinghouse of information for, and a channel of communications between the professions, industry, Government, and others on engineering and scientific manpower.
4. To promote more widespread knowledge of the accomplishments of the engineering and scientific professions.
5. To assist the responsible Government executive agencies in plans for development and administration of sound legislation affecting the education and utilization of engineers and scientists.
6. To assist industry and engineering colleges, in close liaison with Engineers' Council for Professional Development (ECPD) and American Society for Engineering Education (ASEE), in programs to improve and enlarge the teaching and physical facilities of engineering schools with the objective of elevating standards of quality among a growing engineering student body.

In discharging these broad responsibilities, EMC and SMC will maintain close contact with the principle areas of knowledge, interest, and action on this subject in Government, industry, and other private institutions and agencies.

EMC and SMC more specifically will:

(a) Correlate activities with other organizations having similar objectives.

(b) Continue the joint publication of the EMC-SMC *Newsletter*.

(c) Develop concepts of engineering and scientific manpower development, allocation, and utilization for incorporation into military manpower and other preparedness programs to insure the optimum use of this vital resource in the national health, safety, and interest.

(d) Make annual studies of demand for engineers and scientists in industry, education, and Government activities.

(e) Assist in developing realistic concepts regarding the proper utilization of scientific and engineering manpower.

(f) Continue programs in support of high school science education. In this area, EMC and SMC will: (1) support the local activities of the ECPD, (2) work toward improved high school curricula in science and mathematics, (3) co-operate in efforts to recruit qualified high school science and mathematics teachers, and (4) encourage such organizations as the Future Scientists of America Foundation.

Public relations activities of EMC and SMC will be continued to supplement all of these steps. The over-all public relations program will continue to emphasize the importance of engineers and scientists to the national economy and to the defense mobilization effort and the need in mass media advertising and similar activities to depict the engineer and scientist in a realistic and appropriate manner.

EMC-SMC Joint Summary Budget—1957

New York & Washington Office Operations	$ 8,100
Newsletter	7,000
Travel	4,800
Salaries & Incidental Personnel Expenses	54,600
Consultants & Legal Counsel	10,400
Sponsored Meetings	1,500
Surveys	3,000
Printing	3,000
Services	3,200
TOTAL	$95,600

"Computers In Control" Will Be Theme of Symposium

The Feedback Control Systems Committee of the AIEE is planning a symposium on the theme "Computers in Control," to be held at the Chalfonte-Haddon Hall Hotel in Atlantic City, N. J., October 16-18, 1957. Computers will be considered both as utilized as active elements of control systems (for example, computers operated in real time and used as the controller element) and as operated in the design of control systems. Both analog and digital computers will be considered, and specific components and detailed design techniques for the various elements of the computer will be included insofar as the topics are unique or particularly appropriate to problems in feedback control.

The contributions for consideration for inclusion in the program should be sent either to the Feedback Control Systems Committee or to J. G. Truxal, Polytechnic Institute of Brooklyn, 99 Livingston Street, Brooklyn, N. Y.

Membership To Vote on Changes in the Certificate of Incorporation

The Board of Directors, at its meeting of April 5, 1957 in Jackson, Miss., voted to recommend to the membership favorable action on the following resolutions which are to be proposed at the Annual Meeting on the first day of the Summer General Meeting, in Montreal, Que., Canada, June 24, 1957.

On advice of Legal Counsel, the Board decided that the phrase, "and the welfare of those employed in these industries by means of meetings for social intercourse" does not, in the current usage of the terms, correctly express the purposes of the Institute. Hence, the amendment of the second article.

The recent establishment of one new District, and the contemplation of one or two more in the near future, requires that the

limits on the number of members of the Board of Directors be stated more flexibly. This is the reason for the amendment of the fifth article.

The resolutions, as they will be voted on, read as follows:

RESOLVED that Article SECOND of the Certificate of Incorporation, which now reads as follows:

"SECOND: The particular objects for which the corporation is to be formed are to promote the Arts and Sciences connected with the production and utilization of electricity and the welfare of those employed in these industries; by means of meetings for social intercourse, and reading and discussion of professional papers, and the circulation by means of publications among its members and associates of the information thus obtained."

be amended to read as follows:

SECOND: The particular objects for which the corporation is to be formed are to promote the Arts and Sciences connected with the production and utilization of electricity by means of meetings and reading and discussion of professional papers, and the circulation by means of publications among its members and associates of the information thus obtained.

And it is further

RESOLVED that Article FIFTH, as amended, which now reads:

"FIFTH: The number of its directors shall be twenty six (26)."

be further amended to read as follows:

FIFTH: The number of its directors shall be not less than twenty (20) nor more than forty (40).

And it is further

RESOLVED that the officers of this corporation are authorized and empowered and directed to do or cause to be done all things deemed by them and counsel necessary or advisable or proper, and for said officers to execute any and all documents necessary to carry into effect the foregoing.

The Constitution of the Institute provides (C67) as follows:

"Every Fellow, Member, or Associate Member entitled to vote at any meeting may so vote by proxy, signed . . . and filed with the Secretary before the meeting at which it is to be voted."

Session on Extra High Voltage Highlight of Power Conference

One of the outstanding events of the American Power Conference, March 27-29, Chicago, Ill., was the session on Extra High Voltage Systems, under the chairmanship of Dr. Philip Sporn. Among the speakers were two distinguished guests from abroad, F. J. Lane, deputy chief engineer, transmission, Central Electricity Authority, London, England, and Gunnar Jancke, chief engineer in charge of research and development, Swedish State Power Board, Stockholm, Sweden, F. M. Cahen, deputy director of research, Electricite de France, Paris, France, was unable to deliver his paper personally.

The conference, sponsored by AIEE and other national engineering societies, as well as by a number of universities, was attended by some 3,500 engineers.

South Texas Section Honors Fellow

V. H. BRAUNIG (*second from right*), recently transferred to the grade of Fellow in the AIEE, receives his Fellow diploma from Jack Sheehan (*second from left*), member of the South Texas Section. R. M. Jolly (*left*) is chairman of the Section. E. H. Howell (*right*), commercial vice-president, General Electric Company, Dallas, Tex., was principal speaker at the Section meeting during which the presentation took place. Mr. Howell's topic was "A Look Ahead."

Fortescue Fellowship Awarded to Sigmund Scala

The Charles LeGeyt Fortescue Fellowship Committee of the Institute has awarded a fellowship for graduate study in electrical engineering during the academic year 1957-58 to Sigmund Scala. J. H. Lampe, of the North Carolina State College, is chairman

THE SPEAKERS and officers of the session on Extra High Voltage Systems held during the American Power Conference were: (*left to right*) E. T. B. Gross, Chicago, Ill., chairman of the Electrical Program Committee, American Power Conference; F. A. Lane, American Gas & Electric Service Corporation, New York, N. Y.; F. J. Lane, Central Electricity Authority, London, England; Philip Sporn, New York, N. Y., chairman of the session; Gunnar Jancke, Swedish State Power Board, Stockholm, Sweden; and E. C. Starr, Bonneville Power Administration, Portland, Oreg.

Sigmund Scala

of the committee administering the award for the Institute.

Mr. Scala was born in Tarnopol, Poland, on March 20, 1930. During the war, he and his family were deported to labor camps in Germany. After being liberated by United States troops, he resumed his schooling in Polish high schools, organized in Displaced Persons' Camps in Germany. He graduated from high school in June 1948. For one year following graduation, he worked as an interpreter with the International Refugee Organization in the U. S. Zone of Germany. In September 1949, he came to the United States under the Displaced Persons' Immigration Act. Here, he attended evening-school courses at the Illinois Institute of Technology, working during the day.

In January 1952, Mr. Scala was inducted into the U. S. Marine Corps. There, he graduated from the Naval Electronics Materiél School, at Treasure Island, San Francisco, Calif., and the U.S.M.C. Radio Repairmen School in San Diego, Calif. He rose to the rank of staff-sergeant. His service included four months overseas duty. In January 1954, he was released to inactive duty and immediately enrolled at the University of Illinois, in the electrical engineering curriculum, first, in the Chicago, Ill., Undergraduate Division, and later in Urbana, Ill.

Mr. Scala became a naturalized citizen in June 1954. He is due to graduate from the University of Illinois in August 1957.

The fellowship was established in 1939 by the Westinghouse Electric and Manufacturing Company (now Westinghouse Electric Corporation) as a memorial to Charles LeGeyt Fortescue for his contributions to the electric power industry.

Dr. Fortescue, who was graduated from Queens University, Kingston, Ont., Canada, as the university's first electrical engineer in 1898, received 185 patents on electrical inventions during his 38-year career with Westinghouse.

Engineering Societies Form North American Control Committee

Major engineering societies of the United States, with a total membership of 200,000 have formed a five-man "North American Control Committee." The American Society of Mechanical Engineers, AIEE, Institute of Radio Engineers, Instrument Society of America, and the American Institute of Chemical Engineers have selected Prof. Rufus Oldenburger of Purdue University, H. E. Chestnut of General Electric Company, Dr. John Lozier of Bell Telephone Laboratories, Dr. Robert Jeffries of Daystrom Incorporated, and Dr. Joel Hougen of Monsanto Chemical Corporation as their respective delegates to the committee. Prof. Oldenburger is serving as chairman. In addition to the five delegates who form the committee, these societies have appointed one alternate each, W. E. Vannah of McGraw-Hill Publishing Company, Gerhart Heumann of General Electric Company, E. M. Grabbe of Ramo-Wooldridge Corporation, John Johnston, Jr., of E. I. du Pont de Nemours Co. (Inc.), and Prof. N. H. Ceaglske of the University of Minnesota.

The committee was formed to represent the American engineering societies in the organization of the International Control Federation. Participation in this federation has been pledged by the governments or technical societies of USSR, Czechoslovakia, Poland, France, Germany, Belgium, Finland, Holland, Switzerland, Norway, Japan, and the United States and other countries where there is professional automatic control activity. The decision to form such a federation was made at the international control meeting in Heidelberg, Germany, during September 1956. At the Heidelberg meeting A. M. Letov of the Soviet Union, V. Broida of France, O. Grebe of Germany, F. S. Nowacki of Poland, D. B. Welbourne of Great Britain, and R. Oldenburger of the United States were elected to the International Provisional Control Committee to make arrangements for the formation of the International Federation and to promote the idea of this federation. This federation will organize international control congresses and promote the exchange of information on automatic control between the countries of the world.

International control congresses were held in 1950 at Cranfield, England, and in 1953 at New York, N. Y., under the auspices of the ASME. The 1956 meeting at Heidelberg, Germany, under the sponsorship of the German electrical and mechanical engineering societies was the latest international control conference. Over 1,000 persons attended the Heidelberg meeting. The decision to form an International Federation was made by control specialists from Germany, the United States, Great Britain, USSR, Austria, Yogoslavia, Netherlands, Norway, Denmark, Poland, Italy, Israel, Belgium, France, Sweden, Czechoslovakia, Japan, and Switzerland.

The importance of automatic control today is emphasized by the fact that the Soviets graduate 5,000 control engineers a year, the United States only a few hundred. Nevertheless there are over 30,000 engineers in the control field in the United States.

The North American Control Committee will co-ordinate the international effort of the control activities of the American societies. This committee, corresponding committees in other countries, and the International Federation should greatly advance the science and application of automatic control.

Photo by P. Lowell

J. H. FOOTE (*second from right*), vice-president of AIEE District No. 5, presents certificate to Victor Sovick (*center*), past chairman of the Arrowhead Section, as J. E. Abramson (*left*), Section vice-chairman; Lee Day (*second from left*), Section chairman; and Paul Bush (*right*), Section secretary, observe.

Arrowhead Section Visited by AIEE Vice-President J. H. Foote

J. H. Foote, vice-president, AIEE District No. 5, visited the Arrowhead Section in Duluth, Minn., on Friday and Saturday, March 8-9, 1957. During his visit, he was guest at a noon luncheon and Executive Committee meeting of the Section. In the evening, he attended the regular meeting at which time he presented Victor Sovick, of Oliver Mining Company, Duluth, with a certificate for his services as Section chairman for the year 1955-1956.

Mr. Foote is a resident of Jackson, Mich. and represents the Great Lakes District of the AIEE.

The Arrowhead Section, 10 years old, has

112 local members and 84 Institute members and represents northern Minnesota and northern Wisconsin. The membership represents nearly all of the industries in the area including iron mining, railroads, power company, paper mills, manufacturing, consulting engineers, and others.

AIEE Connecticut Section Tours Atomic Submarine Works

The 298th General Meeting of the Connecticut Section of AIEE on March 5, 1957, provided an opportunity for over 150 members to tour the Electric Boat Division of General Dynamics Corp. in Groton, Conn. The tour of the boat works, well known as the builder of the only two nuclear powered ships in the world, the submarines *U.S.S. Nautilus* and *U.S.S. Seawolf*, began at 3 p.m. and included the shipyards with atomic submarines under construction, the research and development laboratories, and the submarine library and museum.

The Commander, Submarine Force, U.S. Atlantic Fleet made arrangements for the group to go aboard an operating submarine of the fleet, the *U.S.S. Darter*, which had, only days before, returned from the Caribbean waters having been on its initial "shakedown" cruise. This new nonatomic submarine had been completed by Electric Board Division and accepted by the U.S. Navy in January 1957.

E. R. Eberle, Jr., test superintendent of the boat works was the speaker at the dinner-meeting which followed. His subject was "Submarine Progress Leading to Present Atomic Submarine Building Program." Mr. Eberle entered the navy in 1941, after graduating from Cornell University in 1936, and was graduated from the Submarine School, New London, Conn., in 1943. During his six-year naval career as a Commander, U.S.N., he commanded the submarine *U.S.S. Cavalla* and earned a distinguished record including many decorations, among them two Bronze Stars and the Submarine Combat Pin with three Stars. His record included six war patrols with the *Cavalla*.

B. P. Baker Receives Patent Award for $5,000

A Westinghouse Electric Corporation engineer—believed to be the company's most prolific active inventor—recently received another patent award for $5,000.

B. P. Baker (F '48), advisory engineer with the company's power circuit breaker department, received the check from the company in a special surprise presentation ceremony held at the East Pittsburgh, Pa., plant. The award brings his total return from invention and patent awards to more than $18,000.

At the same time, Mr. Baker was presented a bound volume containing copies of his first 100 patents.

Dr. J. A. Hutcheson, vice-president in charge of engineering, presented the $5,000 check and pointed out that Mr. Baker has contributed many ideas which have been developments of great value and importance in the advancement of power circuit breakers.

The award was in recognition of fundamental patents covering developments in dead-tank high-voltage power circuit breakers that use compressed air to blast out electric arcs. In the event of short circuits because of a lightning bolt or other fault, breakers protect utility equipment and, if necessary, reroute current around the fault so that normal service can continue where possible.

Dr. Hutcheson observed that features covered by these patents are almost essential in switchyard installation in larger cities. The significance of Mr. Baker's inventive contributions has been recognized

AT THE HEAD TABLE during a dinner-meeting held as part of the 298th General Meeting of the Connecticut Section of AIEE, March 5, 1957, were: (*left to right*) E. R. Eberle, Jr., test superintendent of the Electric Boat Division and principal speaker; J. L. Randall, chairman of the meeting; W. A. Upham, chairman of the Connecticut Section; and D. C. Switzer, vice-chairman of the Connecticut Section.

Georgia Section Activities

T. J. ALLEN (*right*), AIEE Georgia Section chairman, and J. L. Bodeker (*center*), Section member, hear lecture by H. B. Buie, Lockheed Aircraft Corp., during recent display at Architects and Engineers Institute. The Georgia Section now holds its monthly meetings in the Building Industry Center, which is a direct result of the efforts of the Architects and Engineers Institute, Inc., and many interested business and utilities who are locating permanent displays in the building. Space has been provided in the center for future offices of the participating engineering societies, and it is hoped that the Georgia Section will soon be able to locate a permanent headquarters in the building.

not only by Westinghouse in previous awards but also by the electric utility industry which has purchased a substantial amount of equipment involving these inventions.

In the history of Westinghouse, only 12 other men have equalled or surpassed the number of patents awarded to Mr. Baker. All of these men are either retired, or have passed away. In all, Mr. Baker has submitted 188 patent disclosures. In addition to those patents included in the bound leather volume he received, he has 11 other active patent applications now pending.

A native of Winchester, Va., Mr. Baker attended Lebanon Valley College, near Harrisburg, Pa., and later received an additional science degree in electrical engineering from the University of Virginia. Before joining Westinghouse, he spent four years at the University of Pittsburgh on a teaching fellowship and was well on his way toward a doctorate. He joined the company in 1920, worked at the research laboratories and in material and process engineering before moving to the power circuit breaker department in 1929.

AIEE Board Elects C. H. Linder as Director

The Board of Directors of the AIEE has elected C. H. Linder (F '57), vice-president, engineering services, General Electric Company, New York, N. Y., as a director of the Institute.

Mr. Linder will complete the unexpired term of L. F. Hickernell (F '34), Anaconda

C. H. Linder

Wire & Cable Company, Hastings on Hudson, N. Y., who will become treasurer of the AIEE. Mr. Linder's term of office begins August 1, 1957, and expires July 31, 1958.

Mr. Linder was born in Omega, Wis., January 18, 1903. He attended the University of Texas where he received the B.S. degree in E.E. in 1924 and the M.S. degree in E.E. in 1927. He joined the General Electric Company as a student engineer on the company's Test Course in 1924.

In 1950, he was made manager of engineering and manufacturing for the affiliated manufacturing companies department of the company. He became general manager of the Major Appliance Division in 1951 and was elected a vice-president in 1953.

Mr. Linder is a member of the American Society of Mechanical Engineers, American Society for Engineering Education, and the New York Society of Professional Engineers.

AT A LUNCHEON commemorating 50 years of association between the AIEE and the First National City Bank of New York were: (*from left clockwise around the table*) L. S. Brown, vice-president, First National City Bank; F. A. Norris, former AIEE office manager; G. B. Humphrey, Jr., assistant cashier, First National City Bank; W. H. Hassert, assistant trust officer, First National City Bank; L. F. Hickernell, nominee for AIEE treasurer; G. C. Scott, vice-president, First National City Bank; T. M. Linville, AIEE director; George Herrmann, AIEE office manager; S. J. Hill, assistant vice-president, First National City Bank; and N. S. Hibshman, AIEE secretary.

Membership in the American Institute of Electrical Engineers, including a subscription to this publication, is open to most electrical engineers. Complete information as to the membership grades, qualifications, and fees may be obtained from Mr. N. S. Hibshman, Secretary, 33 West 39th Street, New York 18, N. Y.

He has received two honorary degrees—from Worcester Polytechnic Institute in 1955, and from Clarkson College of Technology in 1956.

W. L. Cisler Is Recipient of Washington Award for 1957

The 1957 Washington Award was presented to W. L. Cisler (F '47), president of The Detroit Edison Company, at a joint dinner meeting of the participating societies on Monday evening, April 22, at The Furniture Club of America, Chicago, Ill.

G. L. Jackson, president of the Western Society of Engineers, presented the token of the award which was conferred upon Mr. Cisler ". . . for outstanding and untiring service to his country and mankind by making the world a better place to live through electric power." Following the presentation, Mr. Cisler delivered an address entitled "The Electric Power Industry and the American Competitive Enterprise System."

The award is made annually by the Washington Award Commission composed of nine representatives of the Western Society of Engineers and two each from the AIEE, American Society of Civil Engineers, American Institute of Mining, Metallurgical, and Petroleum Engineers, and American Society of Mechanical Engineers. Chairman of the 1956-57 Washington Award Commission was J. T. Rettaliata.

AIEE Associated for 50 Years with First National City Bank

A luncheon was held recently which commemorated 50 years of association between the AIEE and the First National City Bank of New York. The first Institute deposit was made at the bank in 1907 by F. A. Norris who at the time was office manager of AIEE.

Those attending the luncheon included L. F. Hickernell, nominee for the office of AIEE treasurer; N. S. Hibshman, AIEE secretary and former treasurer; T. M. Linville, AIEE director; F. A. Norris, former office manager; and George Herrmann, present office manager of the Institute. W. J. Barrett, AIEE treasurer and presidential nominee, was unable to be present at the luncheon.

Hosts to the Institute officers were the following officers of the First National City Bank of New York: L. S. Brown, vice-president; G. C. Scott, vice-president; S. J. Hill, assistant vice-president; W. H. Hassert, assistant trust officer; and G. B. Humphrey, Jr., assistant cashier.

EJC Is Described in "The Voice of the Engineer"

Engineers Joint Council (EJC) has prepared a circular entitled "The Voice of the Engineer" which contains answers to the questions What is EJC?, What does it do?, How does it do it?

Included are short descriptions of the nature, origin, manner of functioning, and objectives of the organization which is a federation of professional societies whose memberships total a quarter of a million engineers.

Also briefly described are the activities, services, and the several committees working under EJC.

"The Voice of the Engineer" is to be distributed to the members of the societies that make up EJC.

Anyone wishing information on EJC should write to: Secretary, Engineers Joint Council, 29 West 39th St., New York 18, N. Y.

COMMITTEE ACTIVITIES

EDITOR'S NOTE: *This department has been created for the convenience of the various AIEE technical committees and will include brief news reports of committee activities. Items for this department, which should be as short as possible, should be forwarded to R. S. Gardner at AIEE Headquarters, 33 West 39th Street, New York 18, N. Y.*

General Applications Division

Air Transportation Committee (L. R. Larson, *Chairman;* Peter Duyan, Jr., *Vice-Chairman;* D. H. Scott, *Secretary*). The Committee on Air Transportation has been actively engaged in organizing a technical conference held in conjunction with the AIEE Joint District Meeting in Dayton, Ohio, May 7-9. A full schedule of technical papers was presented in 10 technical sessions held during this meeting.

To sustain the technical activities of the Institute, the subcommittees have been active in the preparation of test codes and guides for use by the Institute and industry.

The Subcommittee on Dielectric Testing Procedures for Electric Equipment and Insulation Materials has prepared an Aircraft Equipment Electrical Insulation Test Code and submitted it to the Standards Committee for release on a one year trial basis. This document overhauls the recommended dielectric testing procedures to reflect the critical requirements of airborne equipment in this specific field.

The Subcommittee on Aircraft Electric Rotating Machinery has compiled a guide report on the Standardization of Presentation of Aircraft Generator and Regulator Characteristics. This report was prepared in co-operation with the A-2 Committee of Society of Automotive Engineers. The preparation of the document was instigated at the request of the airframe manufacturers to achieve agreement among the equipment manufacturers in the manner to be used in presenting engineering data on their equipment. This standardization will alleviate the problem in comparing data

AIEE Michigan Section Meeting

AMONG THOSE PRESENT at the March 12, 1957, meeting of the AIEE Michigan Section held at the Detroit Edison Company were: (*left to right*) C. J. Stettin, executive director of the Port of Detroit Commission, main speaker of the evening; Fred Von Voightlander, chairman of the Michigan Section; and Barkey Toorongian, program chairman. The title of Mr. Stettin's speech was "The Port of Detroit Development." He discussed future plans for a Port of Detroit and the effect of the St. Lawrence Seaway on its development. Mr. Stettin has had a great deal of experience with port authorities. He started with the McCormick Steamship Company in 1928, and has continued to be active in that field. He went to Detroit from the Port of Olympia, Wash., in September 1956 and has made progress in the organization of the Port for the City of Detroit.

New Gem State Section

Courtesy C. B. Brown

MEMBERS of the Bylaws Committee of the Gem State Section, now being formed of the Idaho Falls and Boise Subsections in southern Idaho, burned the midnight oil on April 10, 1957, polishing up the final draft of the bylaws of the new section. Pictured at the Rogers Hotel in Idaho Falls, after completion of their task, are: (*standing, left to right*) J. G. Hannum, Boise; M. P. Coover, Idaho Falls; W. M. Soule, Idaho Falls; M. R. Harrell, Idaho Falls, nominee for treasurer of the new Section; A. M. Brown, Boise; (*seated, left to right*) M. M. Dye, Idaho Falls, nominee for vice-chairman; P. W. Worthen, Boise, nominee for chairman; and R. E. Rubel, Idaho Falls. Also present but not in the picture were J. A. Davis, Salt Lake City, chairman of the Utah Section, who has assisted in the formation of the Gem State Section, and C. B. Brown, Boise.

from several different sources leading to selection of equipment for use of a specific installation.

The Subcommittee on Rating of Airborne Electric Apparatus contributed heavily to the success of the technical program of the aforementioned District meeting. The activities of the members of this subcommittee and others working in the area were formulated into technical papers and were presented to the membership at large.

Power Division

Committee on Power System Communications (L. G. Eaton, *Chairman;* G. E. Farmer, *Vice-Chairman, East;* L. E. Ludekens, *Vice-Chairman, West;* J. L. Evans, *Secretary*). The Power System Communications Committee is planning a symposium for the 1957 Summer General Meeting in Montreal, Que., Canada. Five outstanding engineers in the power system communication field will form a panel and lead the discussion on "Power System Communication Planning." The remarks of the panel members and the discussion from the floor will be tape recorded with the intention that after proper editing the recorded material will be worked into a technical paper, thus providing a permanent record of the proceedings.

The general theme of the symposium will be based on the function to be performed rather than the type of communication channel. After an introduction by the moderator the panel members will discuss the communication problems and solutions for the following functions: relaying, telemetering and load control, supervisory control, dispatching communication, and business communication including teletype, facsimile, and the tie-in with business machines. The special problems in metropolitan areas, particularly cable relaying, will also be covered.

Science and Electronics Division

Subcommittee on Electronics Transformers (H. W. Lord, *Chairman;* L. W. Kirkwood, *Secretary*). The Subcommittee on Electronics Transformers had its organizational meeting on March 20, 1957. The Subcommittee was set up to consider the treatment of the design, construction, and operation of transformers, inductors, and similar equipment as applied to circuits and systems which include electronic devices as circuit elements or as loads. It is the intent here to treat such devices as are not already covered by other committees. The present structure of the organization consists of a Technical Papers Review Group, G. E. Walter, chairman, and three working groups: Power Transformers and Inductors—S. T. Maunder, chairman; Audio and Video Transformers—Reuben Lee, chairman; Pulse Transformers—D. F. Winter, chairman.

Working groups for Luminous Tube and Fluorescent Ballasts, and Computer Type Coils are being set up and consideration will be given to cover other areas should the need arise. Of current interest is the forthcoming Fall General Meeting at which the subcommittee is planning to sponsor its first technical session. G. E. Walter, General Electric Company, Fort Wayne, Inc., is desirous of receiving papers for presentation. In this regard, the final dates for Transaction Papers is July 7, Conference Papers is July 24, and Conference Manuscripts is August 2.

Computing Devices Committee (E. L. Harder, *Chairman;* D. C. Ross, *Vice-Chairman;* S. H. Dodd, Jr., *Secretary*). The Committee on Computing Devices is sponsoring sessions at the Summer and Fall General Meetings, covering several days in each instance.

Growing interest in computers is reflected by the presentation of many papers in national and district meetings. The North East District meeting in May had three sessions devoted to applications, programming, and design of computers. Future sessions are being planned on the application of large scale digital computers to real-time control, on problems of simulation by computer systems, and on air traffic control. Other future sessions are expected to encompass the effect of programming on the design of computers, the design and engineering features of peripheral equipment, and the collection and reduction of data with computing systems.

The West Coast Subcommittee is sponsoring computer sessions at the Pacific General Meeting this year.

Progress is being made toward an international computer meeting tentatively scheduled to be held in Europe in 1958, and the Computing Devices Committee continues actively to promote this matter which was initiated over a year ago. Unesco sponsorship is being sought. Dr. S. N. Alexander has been representing the Computing Devices Committee in working on this in conjunction with other technical societies having an interest in it.

AIEE PERSONALITIES

H. M. Cook (AM '52), district manager, Buffalo-Syracuse sales area, Clark Controller Company, has been named manager of industry sales for the company in Cleveland, Ohio. Mr. Cook received the B.S. degree in E.E. from the University of Colorado in 1938. He joined Clark Controller the following year. Prior to moving to the Buffalo-Syracuse district where he has been district manager for the past six years, he did engineering and development work, and served in the company's Birmingham, Ala., district office. Mr. Cook is a member of the Association of Iron and Steel Engineers.

R. W. Deichert (AM '49), head of the Data Equipment Development Section, Circuit Research Division, Allen B. Du Mont Laboratories, Inc., Clifton, N. J., has been named manager of the newly formed data and display department. Mr. Diechert was graduated from Pratt Institute with a bachelor's degree in E.E. in 1948 and received his M.S. degree from Stevens Institute of Technology in 1950. He joined Du Mont in 1951 and has been active in the Circuit Research Division's work in multiplier phototube evaluations, color television studio equipment, and other special projects. For three and a half years previous to joining Du Mont, Mr. Deichert was an instructor of electrical engineering at Pratt Institute's School of Engineering and at Stevens Institute of Technology. At present, he is a visiting lecturer in electrical engineering at Steven's graduate school. A registered professional engineer in the State of New Jersey, he is a member of Tau Beta Pi, National Society of Professional Engineers, Institute of Radio Engineers, and the Instrument Society of America.

Max Enderlin (M '35), aircraft program director, Federal Telephone and Radio Company, a division of International Telephone and Telegraph Corporation, has been appointed chief engineer of the Semiconductor Division of the company. Mr. Enderlin was born in Switzerland. He received the E.E. degree from the Institute of Technology, Zurich, Switzerland, and has done graduate work at the Polytechnic Institute of Brooklyn. He joined the Federal Telephone and Radio Company in 1943 as senior engineer of rectifier stack design and application engineering. In 1947, he became chief equipment engineer and in 1953 he was promoted to chief engineer of the rectifier equipment department. Prior to joining the company, he was an engineer for Public Service Electric and Gas Company; and was with Gibbs & Hill, Inc., New York, N. Y., as an engineer. Mr. Enderlin is a former chairman and member of the Executive Committee of the AIEE New Jersey Section.

R. F. Schall (AM '46), manager of equipment sales, Switchgear Division, I-T-E Circuit Breaker Company, Philadelphia, Pa., has been named sales manager of the Kelman Electric & Manufacturing Company, Los Angeles, Calif., a recently acquired subsidiary of the I-T-E Circuit Breaker Company. Mr. Schall has been associated with the company since 1951. Prior to joining I-T-E, he had been general sales manager of the Roller-Smith Company. He is a graduate of Lehigh University, class of 1939.

H. N. Skow (AM '44), manager, Pacific Coast Switchgear Division, Westinghouse Electric Corporation, has accepted appointment by W. G. Collins, chairman, San Francisco Section of the AIEE, as representative to the San Francisco Advisory Committee for the Engineering Societies Personnel Service (SFAC-ESPS). Mr. Skow and other representatives of national engineering Society local Sections provide counsel, guidance, and review of San Francisco-ESPS operations to develop an improving Societies' sponsored employment service to western engineers.

H. B. Stallings (AM '47), national sales manager, electromagnetic clutches, I-T-E Circuit Breaker Company, Philadelphia, Pa., has been appointed district manager of the Philadelphia territory of the Weston

Bimonthly Publications

The bimonthly publications, *Communication and Electronics, Applications and Industry,* and *Power Apparatus and Systems,* contain the formally reviewed and approved numbered papers presented at General and District meetings and conferences. The publications are on an annual subscription basis. In consideration of payment of dues, members (exclusive of Student members) may receive one of the three publications: additional publications are offered to members at an annual subscription price of $2.50 each. Nonmembers may subscribe on an advance annual subscription basis of $5.00 each (plus 50 cents for foreign postage payable in advance in New York exchange). Single copies, when available, are $1.00 each. Discounts are allowed to libraries, publishers, and subscription agencies.

Electrical Instrument Corporation, Newark, N. J., a subsidiary of Daystrom, Incorporated. An electrical and mechanical engineering graduate of Illinois Institute of Technology, Mr. Stallings has had over 20-years experience in the sales and sales engineering of electrical and electronic components, as well as industrial instruments. He is a member of the Association of Iron and Steel Engineers and the Engineering Society of Western Pennsylvania.

Gordon Thompson (AM '12, F '46, Member for Life), chief engineer of Electrical Testing Laboratories, Inc. (ETL), New York, N. Y., has been elected vice-president. Mr. Thompson is a graduate of Cooper Union, class of 1909. One of ETL's original incorporators and directors, he has been associated with the enterprise since 1909, except for the years 1920 to 1927 when he served as professor of electrical engineering at Nanyang University, Shanghai, China. An authority in the field of electrical measurements and testing, Mr. Thompson is an editor of several technical handbooks and is active on technical committees of the American Society for Testing Materials. Mr. Thompson has served on the following AIEE Committees: Standards (1939-46), Domestic and Commercial Applications (1941-47), Insulated Conductors (1947-57), and Board of Examiners (1948-57).

J. S. Morgan (AM '39, M 46), director of utility sales for the Industries Group, Allis-Chalmers Manufacturing Company, Milwaukee, Wis., has been appointed director of domestic sales for the Industries Group. Mr. Morgan will be on the staff of the vice president, director of sales of the group. He will be responsible for the administration and activities of the field sales organization of the group which includes the General Products, Industrial Equipment, Nuclear Power, and Power Equipment Divisions. A 1935 electrical engineering graduate of Purdue University, Mr. Morgan joined Allis-Chalmers the same year and was assigned to its graduate training course. He was a salesman in 1937 in the Knoxville, Tenn., district office of the Industries Group, and held various sales, engineering, and managerial positions until his appointment as director of utility sales in May 1954. Mr. Morgan has served on the following AIEE Committees: Carrier Current (1947-48), and Industrial Power Systems (1947-52).

Mark Morgan (AM '51), project engineer, manufacturing research department, International Business Machines Corporation (IBM), Endicott, N. Y., has been named development engineer in the manufacturing research department, Manufacturing Engineering Division. Mr. Morgan holds a master's degree in electrical engineering from the Superior Institute of Technology, Milan, Italy. He served as an electrical engineer in Germany and Italy, and after coming to this country held engineering positions in industry and was an instructor at Worcester Junior College, Worcester, Mass. He is the author of numerous technical articles and papers pertaining to automatic controls. He joined IBM in 1952 as a technical engineer in the methods engineering department. He was later promoted to associate engineer in manufacturing research and in 1955 became project engineer in that department.

I. R. Saddler (AM '51), custom equipment representative for surface communications sales, defense electronic products, Radio Corporation of America (RCA), Camden, N. J., has been appointed manager, materials and modules planning, RCA Components Division. Mr. Saddler was graduated from Texas Western College of the University of Texas with a B.S. degree in E.E. He joined RCA in 1952 as a Government field representative in the Washington, D. C., office of engineering products department. During World War II, he was in the U. S. Army Signal Corps assigned to operate the "Mosquito Network" of the Armed Forces Radio Service in the South Pacific. Later, while in the Office of the Chief Signal Officer, he designed and built transmitting stations for the ACAN network of the Department of the Army. Mr. Saddler is a member of the American Society of Naval Engineers and the Armed Forces Communications and Electronics Association.

OBITUARIES

Donald William Dewey (M '47), superintendent of substations, The Cincinnati Gas & Electric Company, died recently at the age of 43. Mr. Dewey graduated with the degree of electrical engineer from the University of Cincinnati in 1936. He started with The Cincinnati Gas & Electric Company as a co-operative student in 1930. After graduation, he moved up through the electric test department to become operating engineer in charge in 1948. He was promoted to superintendent of substations in 1950, the position which he held at the time of his death. Mr. Dewey was an active member of the AIEE Cincinnati Section having served as director as well as on various committees.

Judson O'Donald Shepherd (AM '34, M '40), F '50), general staff engineer of the Southern Bell Telephone Company, died recently. Mr. Shepherd was born in Beaumont, Tex., November 22, 1900 and graduated from the Georgia Institute of Technology with an electrical engineering degree. He began his telephone career as a student with the Bell Telephone Laboratories in the summer of 1925. The following summer he joined the general engineering department of Southern Bell, and in the summer of 1927, became an engineer in the Plant Extensions Division. In 1948, he was advanced to general plant extensions engineer. In 1955, he was appointed general staff engineer. In this position, he handled special assignments for the general engineering department which included determining the allocation of exchange cable to the several states and serving as the engineering co-ordinator in connection with military matters. During the period 1937 to 1955, he was granted over 30 patents, most of which related to telephone equipment, system improvements, and direct distance dialing. These were licensed to the American Telephone and Telegraph Company. Mr. Shepherd was an organizer and a former president of the Georgia Engineering Society. He also held membership in the Georgia Society of Professional Engineers and the Newcomen Society of North America. He served as AIEE Georgia Section chairman, 1939-1940. Mr. Shepherd served on the following AIEE Committees: Communication (1946-48), Wire Communication Systems (1949-50), and Communication Switching Systems (1950-53).

Jesse Wyman Shuman (AM '13, M '27, Member for Life), retired engineer, died recently at the age of 82. Mr. Shuman was born in Minneapolis, Minn., in 1874. After graduation from the Massachusetts Institute of Technology in 1897, he founded the Power Engineering Company in 1904 and constructed numerous hydroelectric plants in the northern Midwest. His interests were varied. He did research work in weather forecasting and published several papers on the influence of sunspot activity on climatic cycles. Mr. Shuman was an active member in many organizations, including the American Society of Civil Engineers, American Mathematical Society, and American Association for the Advancement of Science.

Leonid Alexander Umansky (AM '16, M '27, F '45, Member for Life), retired engineering manager, Industrial Engineering Division, General Electric Company (GE), Schenectady, N. Y., died recently at the age of 66. Mr. Umansky was born in Nicolaiev, Russia, in 1890. He studied electrical engineering at the St. Petersburg Polytechnic Institute and graduated in 1915, during World War I. In the same year, he was sent to the United States as munitions inspector for the Russian Artillery Commission. After the war, he joined GE in 1919 as test engineer. In 1920, he was transferred to the power and mining engineering department, later known as the industrial engineering department, as an applications engineer. He specialized primarily in power applications in the steel industry. In 1940, he was put in charge of engineering for all GE industrial applications. He was made manager of industrial engineering in 1950 the position he held until his retirement in 1955. Mr. Umansky was awarded the AIEE Edison

Medal for 1955 and received the GE Coffin Award for engineering accomplishments in 1938. He held 18 patents and was a member of the Association of Iron and Steel Engineers. Mr. Umansky served on the following AIEE Committees: Applications to Iron and Steel Production (1936-38); Industrial Power Systems (1938-47); General Industry Applications (1946-54, chairman 1947-49); Industry Co-ordinating (1947-49); Standards (1947-49); Technical Program (1947-49); Lamme Medal (1948-51); and Award of Institute Prizes (1950-53).

MEMBERSHIP

Recommended for Transfer

The Board of Examiners at its meeting of April 18, 1957, recommended the following applications for transfer. Any objection to these transfers should be filed at once with the secretary of the Institute. A statement of valid reasons for such objections must be furnished and will be treated as confidential.

To Grade of Member

Abel, E. D., borough superintendent, Kutztown, Pa.

Albright, J. D., senior electronics engineer, Air Arm Div., Westinghouse Electric Corp., Baltimore, Md.

Althouse, J. W., Jr., asst. supt., Meter Div., Philadelphia Electric Co., Philadelphia, Pa.

Antippa, F. G., managing director, Jordan Central Electric Co., Amman, Jordan

Armstrong, W. M., asst. engineer, Allis-Chalmers Mfg. Co., Pittsburgh, Pa.

Beitman, C. R., construction managment engineer, U.S. Bureau of Reclamation, Billings, Mont.

Benson, J. H., vice pres. & treas., Benson-Wilimzig, Inc., St. Louis, Mo.

Bewley, D. T., development engineer, General Electric Co., Schenectady, N.Y.

Bisson, W. R., distribution engineer, Blackstone Valley Gas & Electric Co., Pawtucket, R.I.

Brandon, Clifford Nathaniel, Jr., supervisor, Westinghouse Electric Corp., Indianapolis, Ind.

Bry, Robert, manager-marketing, General Electric Co., Pittsfield, Mass.

Burgin, Edgar Raymond, switchboard engineer, I-T-E Circuit Breaker Co., Philadelphia, Pa.

Bush, Paul Leroy, chief electrical, Jones & Laughlin Steel Corp., Virginia, Minn.

Chamberlain, Neville Harry, resident engineer, Clough Smith & Co., Ltd., Nicosia, Cyprus

Cobosco, Chester Jacob, supervisor, Reliance Electric & Engineering Co., Cleveland, Ohio

Dana, Gordon McNabb, electrical engineer, Sverdrup & Parcel, Inc., St. Louis, Mo.

Evert, C. F., asst. professor of elec. engg., University of Cincinnati, Cincinnati, Ohio

Farmery, B. L., sales engineer, Bra Bon Electric Corp., Bala-Cynwyd, Pa.

Ford, J. H., apparatus engineer, Line Material Co., North Kansas City, Mo.

Freeman, S. S., professional engineer, Phillips & Elbal, C. E., New York, N.Y.

Gerngross, J. E., engineering analyst, General Electric Co., Schenectady, N.Y.

Gibbons, P. R., transmission superintendent, Tampa Electric Co., Tampa, Fla.

Goodman, B., senior electrical engineer, H. K. Ferguson Co., New York, N.Y.

Hague, C. S., section engineering manager, Westinghouse Electric Corp., East Pittsburgh, Pa.

Harsin, J. C., electrical engineer, Rockland Light & Power Co., Middletown, N.Y.

Havener, R. E., electrical engineer, Mine Safety Appliances Co., Pittsburgh, Pa.

Henkels, H. W., advisory engineer, semiconductor dept., Westinghouse Electric Corp., Youngwood, Pa.

Herder, D. J., technical engineer, General Electric Co., Lynn, Mass.

Hershey, F., Jr., sales engineer, General Electric Co., Philadelphia, Pa.

Hesse, W. E., director of contracts, Shepard Warner Elevator Co., Cincinnati, Ohio.

Janosky, F. R., project engineer, Bell Telephone Co. of Pa., Pittsburgh, Pa.

Jansen, M. A., relay engineer, The Potomac Elison Co., Hagerstown, Md.

Karle, R. O., division plant engineer, General Telephone Co. of Pennsylvania, Erie, Pa.

Kelley, H. E., supervisor of power operations, Goodyear Atomic Corp., Portsmouth, Ohio

Kinitsky, V. A., senior planning engineer, Ebasco International Corp., New York, N.Y.

Knapp, T. K., manager, industry control laboratory, General Electric Co., Roanoke, Va.

Layton, R. E., commercial engineer, The Clark Controller Co., Cleveland, Ohio

Marienfeldt, L., electrical engineer, G. C. Hengy, C. E., Shreveport, La.

Matthews, S. J., III, district engineer, Mutual Boiler & Machinery Insurance Co., Atlanta, Ga.

McCann, R. E., administrator, Southern California Edison Co., Los Angeles, Calif.

Middleton, M., Jr., supervising engineer, Westinghouse Electric Corp., East Pittsburgh, Pa.

Moon, J. B., Jr., district engineer, Southwestern Gas & Electric Co., Mt. Pleasant, Tex.

Morris, H. R., engineer, Air Arm Div., Westinghouse Electric Corp., Baltimore, Md.

Mudd, R. G., sales engineer, James R. Kearney Corp., St. Louis, Mo.

Ottinger, B., engineer, Consumers Power Co., Jackson, Mich.

Paine, C. D., sales engineer, Westinghouse Electric Corp., Shreveport, La.

Palmer, H. L., manager-engineering specialty control dept., General Electric Co., Waynesboro, Va.

Peck, C. E., manager, vacuum equipment projects, Westinghouse Electric Corp., Meadville, Pa.

Port, L. W., partner, Donoghue & Carter, C. E., Sydney, N.S.W.

Power, R. A., staff electrical engineer, Owens-Corning Fiberglass, Santa Clara, Calif.

Pratt, K. E., engineer, Mountain States Tel. & Tel. Co., Boise, Idaho

Raab, E. L., manager, insulation development, General Electric Co., Pittsfield, Mass.

Rosselle, D. T., supervisor, Southern Bell Tel. & Tel. Co., Atlanta, Ga.

Sandell, D. H., staff electrical engineer, Aluminum Co. of America, Pittsburgh, Pa.

Schwyter, E. M., senior electrical instructor, Board of Public Education, Wilmington, Del.

Scohy, J. R., consulting & application engineer, Westinghouse Electric Corp., St. Louis, Mo.

Scruggs, E. B., area manager, Westinghouse Electric Corp., St. Louis, Mo.

Sells, H. C., district manager, Allis-Chalmers Mfg. Co., Knoxville, Tenn.

Sholtis, J. J., power dispatcher, Cleveland Electric Illuminating Co., Cleveland, Ohio

Siegel, R., application engineer, General Electric Co., Washington, D.C.

Skuderna, J. E., electrical engineer, U.S. Bureau of Reclamation, Denver, Colo.

Smith, C.D., communications director, Checker Cab Co., New Orleans, La.

Spainhour, H. F., engineer, Black & Veatch, C. E., Kansas City, Mo.

Spink, P. G., senior engineer, Air Arm Div., Westinghouse Electric Corp., Baltimore, Md.

Springer, E. W., application engineer, General Electric Co., Kansas City, Mo.

Stelzenmuller, B. E., transformer specialist, General Electric Co., Philadelphia, Pa.

Stiles, R. C., senior project engineer, General Telephone Labs., Inc., Chicago, Ill.

Thomas, J. B., asst. prof. of elec. engg., Princeton University, Princeton, N.J.

Thompson, V. N., mining district manager, The Washington Water Power Co., Wallace, Idaho

Thue, W. A., underground engineer, Florida Power & Light Co., Miami, Fla.

Vliet, D. H., associate professor of elec. engg., Tulane University, New Orleans, La.

Wallis, K., supervisor, B.C. Engineering Co., Vancouver B.C., Canada

Wareing, J. F., instructor, New Bedford Vocational High School, New Bedford, Mass.

Wassall, D. E., applications engineer, Pacific Div., Bendix Aviation Corp., North Hollywood, Calif.

Weiss, S., electronic engineer, U.S. Naval Training Device Center, Port Washington, N.Y.

Wollock, M., specialist, design procedures & programming, General Electric Co., Pittsfield, Mass.

Wood, A. J., engineering analyst, General Electric Co., Schenectady, N.Y.

Zambotti, B. M., senior engineer, Cleveland Electric Illuminating Co., Cleveland, Ohio

78 to grade of Member

Applications for Election

Applications for admission or re-election to Institute membership in the grade of Member have been received from the following candidates, and any member objecting to election should so notify the Secretary before June 25, 1957, or August 25, 1957, if the applicant resides outside of the United States, Canada, or Mexico.

To Grade of Member

Addy, G. R., engineer, Narragansett Electric Co., Providence, R.I.

Alfreds, L. J., professional engineer, Telephone Manufacturing Co. Ltd., England, London, England

Anderson, C. B., president, C. B. Anderson Electric Co., Tulsa, Okla.

Betts, H. J., chief electrical engineer, Canadian National Railways, Montreal, Que., Canada

Birman, G., senior consulting engineer, Adalia, Ltd., Montreal, Que., Canada.

Bodine, H. C., vice-president—Engineering, Bodine Electric Co., Chicago, Ill.

Bolimeier, E. W., projects manager, Electro-Mechanical Products Div., Minnesota Mining & Manufacturing Co., St. Paul, Minn.

Cabral, C. A., electrical engineer, U.S. Bureau of Reclamation, Denver, Colo.

Crawford, J. O., chief engineer, Bell Telephone Co. of Pennsylvania, Pittsburgh, Pa.

Crouch, G. W., electrical superintendent, Philadelphia Electric Co., Penndel, Pa.

Dvoracek, A. I., engineer, General Electric Co., Erie, Pa.

Eberly, W. S., metallurgist, special alloys, The Carpenter Steel Co., Reading, Pa.

Esch, H., electrical superintendent, Kaiser Aluminum & Chemical Corp., Newark, Ohio

Ferguson, R. H., acting manager—application engineering dept., Canadian Westinghouse Co., Ltd., Hamilton, Ont., Canada

Hahne, K. H., manager of development & research, Osnabrucker Kupfer-und Drahtwerk, Osnabruck, Germany

Halliday, W. M., development engineer, Leece-Neville Co., Cleveland, Ohio

Hinkley, J. W., president, Research Corporation, New York, N.Y.

Hogan, C. L., professor of applied physics, Harvard University, Cambridge, Mass.

Hollister, F. J., engineer, American Gas & Electric Service Corp., New York, N. Y.

Inglis, A. F., manager, TV Systems Engineer, R.C.A., Camden, N.J.

Johansson, K. T., chief engineer, Kommunala Elverks AB, (Power & Light Co.), Katrineholm, Elverket, Sweden

Kappeler, C. P., engineer-in-charge, distribution design, Allis-Chalmers Manufacturing Co., Pittsburgh, Pa.

Kelly, E. J., electrical engineer, Philadelphia Electric Co., Philadelphia, Pa.

Kramer, A. W., Jr., (re-election), General Electric Co., Roanoke, Va.

Loew, R. A., electrical design engineer, Hinkston & Norcross, Inc., Los Angeles, Calif.

McWhorter, A. D., Jr., partner, McWhorter & Franklin, Engineers, Nashville, Tenn.

Miller, C. G., (re-election), consulting engineer, 249 North Mountain Ave., Upper Montclair, N.J.

Mullerheim, K., patent agent, Automatic Electric Co., Chicago, Ill.

Noble, R. V., electronic engineer, Sperry-Utah Engineering Lab., Salt Lake City, Utah

Robertson, V. S., district engineer, Southern Bell Tel. & Tel., Tupelo, Miss.

Schlotterbeck, R. S., manager, component engineering, rectifier dept., General Electric Co., W. Lynn, Mass.

Sze, W. C., electrical engineer, National Bureau of Standards, Washington, D.C.

Weinberg, P. H., sales engineer, Philadelphia Electric Co., Philadelphia, Pa.

Wittman, G. J., vice-president, Electra Motors, Inc., Anaheim, Calif.

34 to grade of Member

ELECTRICAL ENGINEERING EDUCATION

AIEE in the U.S. Naval Academy

THE STUDENT BRANCH of the AIEE at the U.S. Naval Academy, Annapolis, Md., was authorized January 25, 1951. Prof. D. G. Howard was appointed counselor, and the first chairman was Midshipman H. F. Hicks, Jr., of the class of 1952.

There are no "EE majors" in the academy, since all midshipmen pursue the same course of study; but in the brigade of about 3,700 there are many who have a special interest in electrical engineering, and consequently join the AIEE Student Branch.

In the department of electrical engineering, electrical circuits and machinery are taught in the third year; and fourth-year midshipmen study electronics and radio, with specific applications to the naval service. In each year, the student attends a weekly laboratory exercise. This year there are 960 juniors and 856 seniors. The future officer thus is prepared for a navy where electricity is used extensively for power and control functions and also is given a firm foundation for later specialization.

Tecumseh (*right*), the "God of 2.5"—a passing mark—is a bronze copy of the figurehead from a Civil War frigate. The midshipmen toss pennies at him for good luck in examinations.

Official U. S. Navy Photograph

Old Ideas and Later Inventions

EMANUEL ROSENBERG

AN INTERESTING EXHIBITION "Leonardo da Vinci as Inventor" was shown a few years ago in several cities of America. The models were admirable but I had grave doubts about the educational value of the exhibition which was visited by thousands of school children without the guide of an expert. Many of them left the show with the idea that Da Vinci, among scores of other things, had invented the flying machine; not knowing that all endeavours of human beings to lift themselves in still air, even for minutes, was doomed to failure as long as no motor existed in which the ratio of power to weight was far better than in human beings. The boys and girls could not know that Da Vinci was as far from the solution of the problem as the old Greek poet who had invented the beautiful tale of "Daedalus and Icarus."

The design of electrical machines is not so old as the human dream of flying. The year 1882 represents "Antiquity" or "Middle Age of Electrical Engineering." Many people will have been struck by a statement of A. Tustin, made in a discussion in 1953 and published two years later,[1] which stated that A. I. Gravier of Paris, France, had filed in 1882 a British Patent No. 1211 that "clearly describes the principle of the cross-field constant current generator, referring to a Gramme ring. This was the ancestor of the Magnicon, as well as the Rosenberg generator, the Metadyne and the Amplidyne." I was very curious to see the old patent and Mr. Richard Neumann of London, England, who in previous years had much to do with the Rosenberg generator,[2] sent me a copy of it. Even, he, at first, had the same impression as Tustin, but I hope that what follows will make it clear what Gravier did and what he did not achieve.

Gravier's Patent Drawing

Figs. 1, 2, 3 and 4 reproduce Gravier's patent drawing taken from the "Third edition" of the patent, which seems to show that the patent was repeatedly quoted to later inventors, most likely to draw their attention to Fig. 2, which represents a Gramme armature with two windings and two sets of brushes, displaced by 90 degrees. Figs. 2 and 3 of the patent refer to a machine with rotating ring armature, whereas Fig. 1 serves as explanatory introduction, and Fig. 4 assumes that the armature is fixed in space, while the brushes rotate. A small permanent 2-pole magnet in the center is not clearly described, but in the opinion of the inventor it should be sufficient to initiate the excitation.

Gravier wanted to construct a light and cheap machine by using an armature "with both inductor coils and induced coils" and dispensing with the stationary field coils. In Fig. 2, the "inductor coils" are represented by a full drawn winding and two full drawn brushes f f in the horizontal line A B, connected to a battery for "primary excitation." The "induced coils" are

Dr. Emanuel Rosenberg lives in Bogota, Colombia, South America.

drawn in dotted lines with brushes *f' f'* in the vertical diameter *O O'*. The brushes *f f* carry the exciting current, *f' f'*, "the generated current." The two commutators for the two windings are not expressly shown. In Fig. 3 a "mass of iron in front of the consequent poles" of the armature is shown "which forms a part of the framing of the machine." Although it is said: "It may also be found advisable in some cases to place a mass of iron . . ." it can be assumed that the first experiments must have convinced the inventor that the mass of iron, even with a moderate air gap around the armature, is essential. It is inefficient because it does not give to the primary and secondary fields full opportunities to develop. But, we may assume that in experimenting, the inventor would have substituted the beam-like mass of iron with something like a ring around the armature, provided the first tests would have fulfilled the expectations and the promises of the inventor.

Gravier believed that the exciting current for the inductor coils "may be supplied wholly or partially by the current induced in the secondary coils," but to me that seems as difficult as the feat of Baron Münchausen in one of his tales when he reported that he had managed to pull himself out of a swamp by his own hair. Gravier adds " . . . it is necessary that there should be an exciting fund at the commencement. This fund may be either the current from a secondary battery for priming, a permanent magnet, or even the magnetism of the earth itself: the movement of the coiled ring will do the rest."

Gravier's Fundamental Error

I consider this to be Gravier's fundamental error. There is no possibility of strengthening a small initial magnetism by the secondary current. A small primary magnetism causes a small current in the primary winding. This creates a secondary field, displaced by 90 degrees against the primary, which will induce a small voltage and a small current in the secondary winding. But the secondary current again produces a field, which is displaced by a further 90 degrees and, therefore, 180 degrees against the primary field. Hence, an opposing electromotive force (emf) is created in the primary winding. Gravier apparently did not know this. In his time, the knowledge about armature reaction clearly was not so general as in later times.

The diagram shown in Fig. 5, which I used in my papers of 1905 for the cross-field generators[3] of Figs 6 and 7, can also be employed for the fields which occur in any generator with two sets of brushes at right angles to each other. Suppose *O-I* in Fig. 5 represent an initial magnetism of the primary field. Then in the direction of *O-II*, at right angles to *O-I*, a secondary field would be created, but only a small one, because the primary field *O-I* is small. If the secondary armature winding is closed, enabling a current to flow, this induces in the primary winding a field in the direction *O-III* which, however, must remain smaller than the original field *O-I*. Only if an additional excitation *I I'* is added from outside sources, can the secondary current grow to such a limit that the tertiary field (which creates the counter emf) will nearly equal the primary *O-I'*.

The additional excitation *I I'* in a cross-field generator (Fig. 7) can be provided either by a series coil or by dimensioning the shunt coil from the start, in order to give the full field *O-I'*. All the stationary field coils together require (as in all standard machines) only a small percentage of the armature output. It is quite different in Gravier's Fig. 2. The only means to increase the secondary current is an increase of the primary current, accompanied also by an increase in voltage, because the primary as well as the secondary winding are moving in a stronger field. The motor current, which flows through the primary winding, is opposed to the counter emf and will have to be increased with increasing secondary current. In principle, also, the cross-field machine (Fig 7) can work as a motor or converter without field coils and has a speed characteristic like a series motor (reduced speed with increased torque). But the converter of Gravier's Fig. 2 has the inherent vice of all converters (even of the best design) that the energy input must be greater than the output. If Gravier does not work from a battery, he must first have another generator (of ordinary design) which has greater output than the converter.

Despite the wishful thinking expressed in Gravier's specification, his machine will not work as a self-exciting generator. He

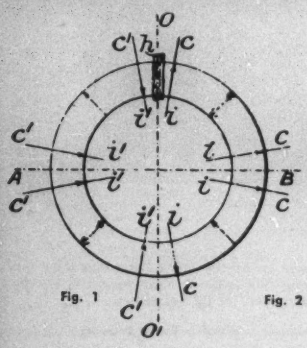


Fig. 1

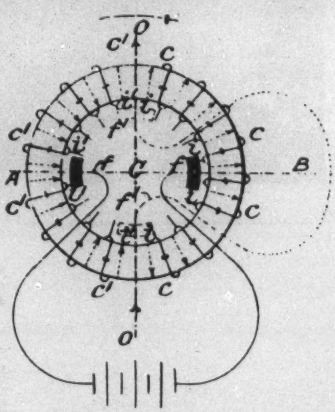


Fig. 2

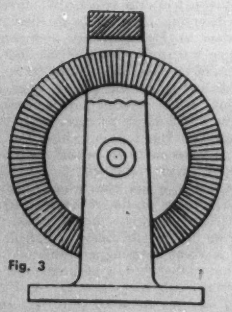


Fig. 3

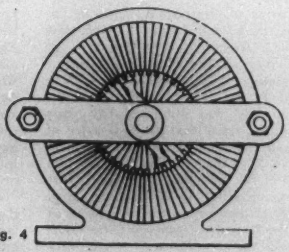


Fig. 4

Gravier's Patent Drawing of 1882

Fig. 1. (upper left) Explanatory introduction. Fig. 2. (upper right) Armature. Fig. 3. (lower left) Field frame, no field coils. Fig. 4. (lower right) Small permanent magnet for priming.

explains correctly that it will work as a converter from d-c to d-c and also from d-c to a-c, if instead of the second commutator, slip rings are fitted. As a converter, the armature must carry ampere turns and field for double the output as an ordinary generator. The additional cost of the armature would much more than offset the economies effected by the saving in field coils, apart from the fact that in addition to all that, another generator of slightly greater output is required to supply the current that must be converted.

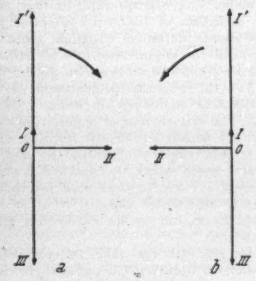


Fig. 5. Diagram of field of ampere turns in a cross-field generator (1905).

I do not know whether Gravier was the first to use intermediate brushes, midway between the two brushes of a d-c machine. In my papers of 1905, I mentioned the three wire generators of Kingdon and Dettmar, and also the Winter-Eichberg single-phase commutator motors. If Gravier was the first to use them, one may consider him as the inventor of a new tool in designing electric machinery, although he did not apply it to advantage. His dispensing with the stationary field coils made the machine impossible as a generator and brought no advantage to the converter.

But one may argue: the stationary field winding was known long before 1882 and it was only necessary to combine it with Gravier's new tool. In this way, of course, every invention can be reconstructed, after it once has been made. But it is not made in this way. Inventions that have caused no practical improvements remain in general unknown and must be made anew by somebody who finds an application for the new tool.

Background of Rosenberg Generator

In 1904, I did not start with the idea to use two fields at right angles to each other. My idea was to build a generator with fixed brushes, which would give the same polarity for either direction of rotation. A direct coupled exciter with constant field would reverse the field of the main generator, when reversed; and my aim was to combine generator and exciter. Déri had once suggested a motor to work from d-c and a-c in fields with distinct number of poles and so I tried a ring armature in a four pole field with field coils that created a superposition of a two pole and a four pole field. (More than 40 years later, Westinghouse Electric Corporation built their Rototrol [registered trade mark] on this principle.) But in experimenting with the four brushes at random, I found the better solution to use two fields at right angles to each other, which also provides the advantage that the armature reaction (the tertiary field) is in straight opposition to the primary field and is, beginning from a certain low speed, nearly equal to it, giving nearly constant current.

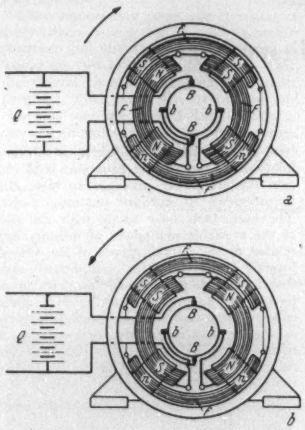


Fig. 6. Cross-field generator with 2-phase stator winding (1905).

I knew I could use a compound or compensating field winding to obtain another characteristic curve, but it was six years later that J. L. Woodbridge of Philadelphia, Pa., designed my machine with a compensating winding and a control coil for such a small current that the small differential current across a Wheatstone bridge with links of iron wire in hydrogen bulbs sufficed to regulate for constant voltage.[4] About 1940, Alexanderson and his associates at the General Electric Company used the same compensating winding with control coil and certain improvements as Amplidyne (registered trade mark) to obtain an armature current, amplifying the control current in a ratio up to 10,000.[5] Pestarini in his Metadyne (registered trade mark) had used the cross-field principle for a new converter, which, among other things, could convert constant voltage to constant current.

We all used the armature reaction and the two sets of brushes, which Gravier had described in 1882, but none of our aims could have been achieved without control of stationary field coils which Gravier did not employ. He had not pursued any of the aims of the later inventors.[6] The machine that he invented could, in principle, be used as a motor (although without starting torque) or as a converter, but not as a generator. He achieved neither the same polarity in either direction of rotation, nor anything like constant current or constant voltage with different speeds and not a current proportional to a small control current.

To return to the preamble of this paper, the invention of the flying machine: a light, powerful engine was necessary to enable man to fly in still air[2] in a predetermined direction.[7] But using air currents, one may fly a glider plane without motor. Lilienthal, at the end of the 19th Century, before his fatal accident, was able to show success. Today, after much has been learned from the design of and the experience with engine driven airplanes, gliding is a sport no more dangerous than many other sports. By carefully studying old books and specimens of old materials, we may be able to

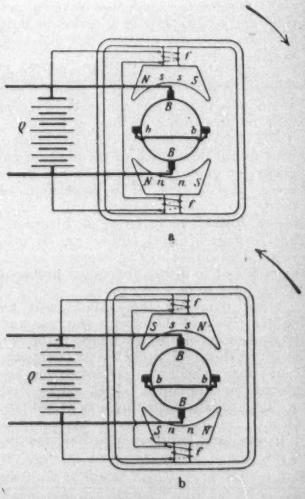
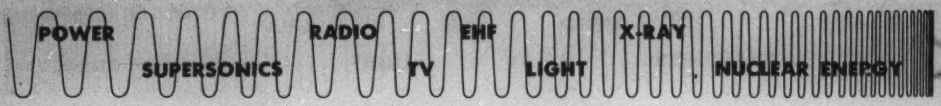


Fig. 7. Cross-field generator with short circuited aid brushes (1905).



prove that a glider could have been built with the materials that were available in Da Vinci's times, or even thousands of years before that time. But it was not made then.

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The Engineering Graduate and the Problem of Military Service

W. T. CAVANAUGH

AS THE SCHOOL YEAR draws to a close a fact to be faced by most engineering graduates is that of military service. For some, R.O.T.C. graduates for example, it is a relatively simple problem because the course is pretty clear, and is charted, for the most part, by the military authorities. In these times, however, almost all other engineering graduates who are physically acceptable (assuming there is no mental disability among college graduates—especially engineering graduates) have to consider the relationship of a period of military service to post-college plans and engineering career development.

Unlike R.O.T.C. graduates, this group has several possible courses of action. These alternatives in military manpower programs have resulted in a great deal of confusion. There certainly is need for clarification, with special orientation to the needs of engineering graduates looking forward to career development. It is impossible, of course, to explore completely all avenues of the situation in an article of this length, but perhaps a useful outline can be provided. The author will be happy to answer questions or to discuss individual problems which some readers may have.

Please remember that this is only an outline report of the present situation and is not meant to be an appraisal of the programs discussed. In the future, an opportunity may present itself to discuss the Engineers Joint Council (EJC) policy and attitudes toward this entire area of military service.

It may seem unnecessary to state the obvious, but it seems advisable to mention here that the primary objective of military manpower procurement programs is to obtain the manpower necessary to meet the requirements of military manning tables. The basic facts have to do with the size of the available manpower of military age related to the varying needs of the armed forces. There is great complexity and, therefore, each procurement program must be planned to prevent clashing with other equally important considerations, inasmuch as the military manpower organization is like a jelly fish—the entire organism can respond to a touch in any given area. This fact should be kept in mind as this discussion of the principal alternatives is developed.

First, just what is the military obligation? Simply stated, it is that every man between age 18½ and 26 who enters the armed forces after August 9, 1955, has a total military service obligation of either six or eight years, depending on the manner in which he decides to discharge it. In most cases, these total periods are the sum of periods of active duty (or active duty for training) and reserve service in the "Ready" and "Stand-by Reserve."

First of all, graduates should remember that the student deferment program includes graduate work. Qualified graduate students are permitted, under Selective Service Regulations, two years deferment for the masters degree, and four years for the Ph.D. Many graduate students, and undergraduate students for that matter, currently are not called, simply because they are not yet needed by the local board to fill Selective Service levies. This type of delay for academic work may, in the future, become precarious for reasons that will emerge later.

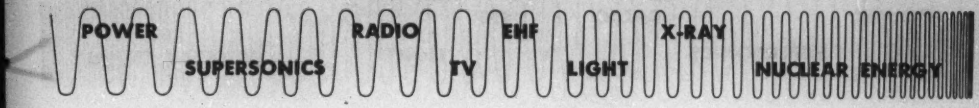
It is possible, of course, to enlist in any of the services for varying periods (minimum—three years). From the point of view of engineering professional development, it should be realized that this probably is the poorest choice for the engineering graduate to make. The reason simply is that, with the exception of the Army Scientific and Professional Personnel Program, there are practically no engineering jobs for enlisted men in the armed services. Do not be misled by the pictorial presentation of the products of technology in military literature. The vast amount of engineering work required within the armed forces is done by civilian engineering employees and, to a much lesser extent, by experienced officer personnel. There is great need for technicians in an enlisted capacity in all of the armed forces, but not for engineering graduates.

The graduate can take an engineering position in industry, Government, or education, and perhaps qualify for occupational deferment, which may continue indefinitely under the proper conditions or terminate, perhaps with qualification for entry into the six months Critical Skills Program.

The Selective Service Occupational Deferment Program has had a long and somewhat bumpy history. Its genesis is rooted in the recognition that modern military effort requires an enormous amount of critical industrial and technological activity and that certain kinds of personnel ("specialized personnel" in Government language) in short supply are, for that reason, critical to the effectiveness of that support. Thus, the concept of critical activities and critical occupations has been developed. Under the regulations, a person to qualify for deferment has to have, among other things, a critical occupation (all engineering occupations are critical) and be employed in a critical activity. A list of the critical occupations and activities is available, with other detailed information on this subject, from local boards of the Selective Service System. They have also been published in several EJC documents which have been given wide distribution, including all deans of engineering.

Occupational deferments are normally given for a specific period, such as six months or one year and are, theoretically, renewable in indefinite sequence. As a matter of practice, however, local boards want, at some time, to terminate these deferments to ensure that a person is not deferred to a point where his induction, though legally possible until age 35, is impractical for reasons of age, dependency status, hardship, etc. The six months Critical Skills Program was put into the Reserve Forces Act of 1955 and implemented by executive orders in early 1956 to provide a practical and workable solution of the previously unyielding problem of the need for selectivity versus the theoretical need for equity.

W. T. Cavanaugh is executive secretary, Engineering Manpower Commission of Engineers Joint Council



Detailed information on the Critical Skills Program can be obtained from your local board or EJC. The basic requirements are a 1A classification, and a critical occupation in a critical activity. Unlike occupational deferments (in which the employer is the requesting agent), the registrant himself applies for the Critical Skills Program by a letter to his local board. This may be done even after notice of induction is received. Such application automatically suspends all other procedure pending its processing. Upon acceptance, the registrant must, within 30 days, enlist in an Army, Navy, or Air Force Reserve Program. He will be called for six months of active duty for training, after which he is returned to civilian pursuits and is transferred to the Ready Reserve.

The Armed Forces Reserve Act of 1955 provided statutory authority for the reorganization of the Military Reserve Forces into a Ready Reserve and a Stand-by Reserve. The Ready Reserve is an unconditionally available force immediately callable by the Department of Defense. Its members must (after August 1957) take part in weekly and annual training. Persons in the Stand-by Reserve are callable only in time of a congressionally declared emergency, and only after they have been declared available for call by the Selective Service System. The Stand-by reservist has no weekly or annual training obligation.

The Reserve Forces Act of 1955 and subsequent regulations also provide for the continuous automatic screening of the Ready Reserve. As mentioned earlier, all persons between 18½ to 26 entering the armed forces after August 9, 1955, have a total military obligation of either six or eight years. Persons who enter via active service (two years or more), have a total obligation of six years. They serve in the Ready Reserve (unless screened out) for a period which, when added to the period of active service, totals five years. Persons who enter via active duty for training (six-month people) have a total obligation of eight years, for the most part in the Ready Reserve, unless they are screened out.

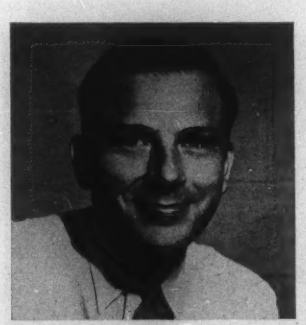
The screening process is automatic, and is designed to insure, among other things, that persons with critical skills who have these statutory obligations to serve in the Ready Reserve, are actually retained in the Ready Reserve only if requirements exist for their skills, or if they have an overriding military specialty. Persons with critical civilian skills who are in excess of requirements for these skills are to be transferred to the Stand-by Reserve. Thus, an engineer, not needed (as an engineer) in the Ready Reserve, will be transferred to the Stand-by Reserve. The exception would be an engineer who is also, say, a jet pilot, or possesses some other critical military specialty. In that case, he would be retained in the Ready Reserve at the convenience of the armed forces concerned, possibly for the entire statutory requirement. As a matter of practice therefore, it is anticipated that persons with critical skills (whether six-month Critical Skills Program people or two-year service people) will spend relatively brief periods in the Ready Reserve.

The Critical Skills Program came into being in 1955 as part of six months reserve training program for men less than 18½ years of age. The purpose of the latter program was to "beef up" the Ready Reserve with younger men on a voluntary basis. After a year of trial, it was realized that the program was not meeting its goals. As a result, the general six-month program was opened earlier this year to men between 18½ and 26.

This immediately raises the question of differences between the general six-month program and the Critical Skills Program. There are two important differences. First, the general six-month program is a quota program. That is, it will be opened and closed as men are needed. Incidentally, as more men enter the six-month program, the number of men available for military service should be reduced, thereby reducing the chances of obtaining delay equivalent to Selective Service deferment because men are not needed. But the Critical Skills Program is a continuing one. Application for the Critical Skills Program can be made even after receipt of notice of induction. This is not so in the general program. Of course, the screening process applies to all personnel regardless of method of entry into the Reserve Forces.

As is generally known from much public discussion earlier this year, the National Guard now has an enlistment program very similar to the U.S. Army Reserve. There are many interim minor differences and one major one of permanent importance to engineers and other specialized personnel. It is this. The National Guard is considered part of the Ready Reserve. However, it is not clear that the automatic screening process will apply to the National Guard. Even if the various state governors are sympathetic to it, from a practical point of view, it would depend on individual request and present a very difficult, decentralized administrative problem.

An Electrical Engineer in Industry



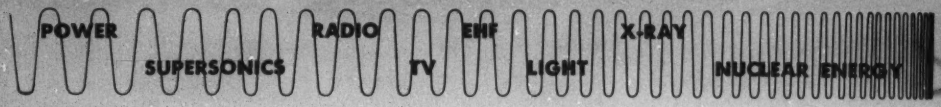
C. S. LAPINSKI (AM '40), group leader, infrared instrument development, Engineering and Optical Division, The Perkin-Elmer Corporation, Norwalk, Conn.

"Technical journals serve the practicing engineer in the same manner that textbooks serve the student in his formal education. They are the only source of up-to-date theoretical and practical technical information on developments in the fields of interest to the engineer.

"In addition to publishing excellent journals and transactions, the AIEE furthers the exchange of technical ideas by means of regular meetings and conventions. The formal and informal discussions at these functions not only serve the main purpose of disseminating technological information, but also broaden the outlook and promote good fellowship among the practicing engineers."

Mr. Lapinski received his B.S. degree in E.E. from Rensselaer Polytechnic Institute. His background includes engineering design and development work on long-, short-, and microwave equipment of standard and printed-circuit design. He has been employed as project engineer and supervisor of engineering in such leading organizations as the General Electric Company and Remington Arms Division of E. I. du Pont de Nemours and Co. (Inc.). Mr. Lapinski is currently in charge of infrared instrument development in the Engineering and Optical Division of the Perkin-Elmer Corporation. He has been active in the teaching field, having taught electrical engineering and calculus at the Bridgeport Engineering Institute. Mr. Lapinski is a member of the Institute of Radio Engineers as well as the AIEE, and has achieved outstanding recognition in the field for his many accomplishments.

Electrical Engineering Education



Preparation for Engineering Careers Increases

More students are preparing for engineering careers this year than at any time since 1948.

Figures compiled by the U. S. Office of Education (U.S. Department of Health, Education, and Welfare) and the American Society for Engineering Education (ASEE), published by the ASEE show a total of nearly 243,000 studying in accredited engineering colleges last fall.

This total is almost equal to the all-time high of 1947, when the colleges were jammed with World War II veterans. And today's trend is still upward.

These increasing numbers, says Dr. W. L. Everitt, dean of the College of Engineering at the University of Illinois and president of the ASEE, emphasize the "overwhelming problem" of engineering colleges—a shortage of qualified teachers to meet predicted needs.

Industry seeking more engineering graduates than it finds in college placement offices may take heart in this year's figures. The enrollment of senior (fourth-year) students in engineering this fall was up 20% over 1955, when graduates numbered nearly 24,000.

Engineering students this year amount to 12.5% of the total of men attending colleges, compared with 12.1% a year ago. "Engineering enrollment has shown steady and accelerated year-to-year increases since 1951," says Dr. H. H. Armsby, chief for Engineering Education in the Office of Education.

Dr. Armsby and S. J. Armore, chief of the Office of Education's Statistical Services Section, collaborated to prepare the engineering enrollment statistics, obtained with the co-operation of the ASEE.

The figures published cover all institutions in which one or more engineering curricula are accredited by the Engineers Council for Professional Development, the nationally recognized professional accrediting group. The Office of Education will soon publish figures covering all the nation's engineering schools, both accredited and nonaccredited.

Dean Everitt calls this year's figures "encouraging." But, he says, "the growing importance of technology and its increasing applications in industry and defense mean that the demand for well-educated engineers must continue to rise. America's engineering colleges must find the means, both financial and physical, to meet the growing needs which today's figures forecast."

Graduate studies in engineering also show a rapid gain in popularity, although the numbers involved still are small. This year's 22,240 master's degree students is 20.8% more than the number last year, the largest increase reported in any category in this year's survey. About 3,400 students are working toward doctor's degrees in engineering this year (up 7.6%).

Engineers graduating with bachelor's degrees during 1955-56 totalled 23,547, compared with 20,200 in the previous year. In 1949-50, when the peak of World War II veterans were finishing their college careers, 48,160 engineers were graduated. But the numbers declined rapidly after that, and especially since the Korean War the nation has been feeling an increasing pinch in the supply of competent talent.

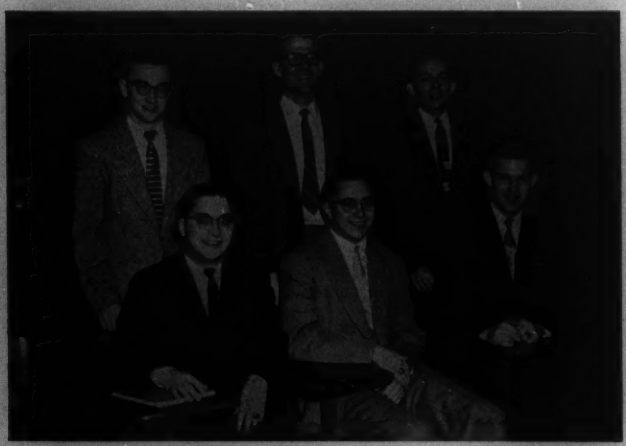
Mechanical engineering is the most popular field among engineering graduates of the last eight years, followed closely by electrical engineering, and then by civil, chemical, and industrial engineering, in that order.

But electrical engineering is today's most popular field, and 20% of this year's undergraduates expect to take electrical engineering degrees. Nearly 17% are in mechanical engineering, and civil, chemical, and aeronautical engineering (rising rapidly in popularity, too) follow in that order. Electrical and aeronautical engineering are growing fastest as college students' choices.

The same five fields figure in master's degree students' choices, with electrical engineering leading and mechanical, chemical, and civil following closely.

The highest number of doctor's degrees awarded during the past eight years has been almost consistently in chemical engineering, with electrical engineering second, mechanical third, metallurgical fourth, and civil engineering fifth.

The full report on 1956-57 enrollments was published in the March 1957, number of the *Journal of Engineering Education*, official ASEE monthly.



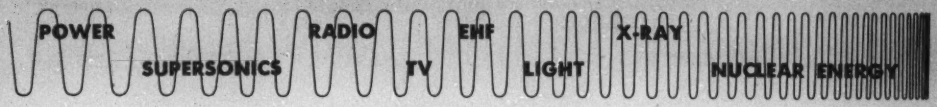
UNIVERSITY OF NOTRE DAME students who competed in the student paper contest sponsored by the South Bend Section of the AIEE were: (*seated, left to right*) William Lennon, Matt Slana, Ron Koontz, (*standing, left to right*) George Breen, Ben Kleindorfer, and Donald Calahan, winner of the competition.

AIEE South Bend Section Holds Student Paper Contest

As has been the annual custom, the March meeting of the South Bend Section of the AIEE had as its program the student paper competition of the University of Notre Dame Joint AIEE-Institute of Radio Engineers (IRE) Student Branch. This year the number of competitors and the general level of the papers suggested that six papers rather than the usual four be included on the program.

The student competitors were: George Breen, Hollis, N. Y., "Single Side Band Transmission"; Donald Calahan, Cincinnati, Ohio, "Analog Simulation"; Ron Koontz, Tarzana, Calif., "Delay Lines"; William Lennon, Niagara Falls, N. Y., "Cypak, Control without Moving Parts"; Matt Slana, Joliet, Ill., "A New Binary Computer Scheme"; and Ben Kleindorfer, N. Judson, Ind., "A Brushless Dynamo." First prize was awarded to Mr. Calahan.

The South Bend Section furnishes the judges and $25 of prize money for this annual competition. Their co-operation has



been a contributing factor in the favorable participation by students.

Counselor for the Joint Student Branch at the University of Notre Dame is L. F. Stauder ('43), professor of electrical engineering.

The Section and the Student Branch in a jointly sponsored meeting on April 9 had the privilege of hearing J. H. Foote, vice-president of AIEE District No. 5.

Carnegie Tech Announces Building and Development Program

Carnegie Institute of Technology has announced a $24.35 million building and development program which will enable the school to continue as a great seat of learning, knowledge, research, and creative attainment.

The multimillion dollar program was announced jointly by the co-chairmen of the Carnegie Development Program, B. F. Fairless, chairman of the executive committee United States Steel Corporation, and G. A. Price, chairman and president, Westinghouse Electric Corporation, at a "kick-off" dinner at the Duquesne Club, Pittsburgh, Pa. Attending the dinner were 350 leading executives of business and industry.

The building and development program is centered on men and facilities and has five objectives.

(1) Increases in faculty salaries.

(2) Additoinal outstanding teachers for the faculty.

(3) Construction of four new buildings: a Library, another engineering and science building, a dramatic arts center including a modern theater, and a campus activities center.

(4) Improvement of existing facilities.

(5) Extensive campus improvements (parking and recreation).

The program is the first extensive public fund-raising effort in the 57-year history of Carnegie Institute of Technology.

Michigan Section Is Active in High School Student Guidance

A program of student guidance at the high school level as developed by the Michigan Section of AIEE has been expanded into an effort sponsored by the 6,500-member Engineering Society of Detroit. This is the natural outgrowth of a study initiated in 1952 by the Michigan Section Student Guidance Committee.

The work of this Committee began by contacting the Board of Education of Detroit and those of surrounding communities to obtain factual information on the needs of educators in providing vocational guidance to students. This was followed by actual field work with individual high schools in the form of talks before student assemblies. Finally, the three years experience resulted in the publication of a "Student Guidance Manual."

Once field work was begun in the metropolitan Detroit high schools, it became immediately apparent that: (1) the Committee could not possibly cope with the manpower requirements for a counselling service to the 90 public and parochial schools in the area; (2) high school students wanted specific information on the various engineering fields; and (3) several different technical groups were making independent and sincere efforts but were quite unaware of each other.

The need for a co-ordinating agency able to meet the manpower requirements was obvious. Fortunately, it was already in existence in the form of the Affiliate Council of the Engineering Society of Detroit. This Council is an organization representing the 46 societies in the fields of engineering, science, and mathematics in the metropolitan Detroit area.

In October 1956, B. J. Drummond, chairman of the Michigan Section Student Guidance Committee, presented the proposal to the Affiliate Council. It was wholeheartedly approved and a Student Guidance Committee of the Affiliate Council was formed with Glenn Coley as chairman. The AIEE approach as outlined in the Manual was accepted in total and 150 copies of the Manual were distributed to Affiliate Council representatives. Since then the program has progressed at a fast pace. Clearance from the Detroit Board of Education has been obtained. High schools are already requesting this counselling service and a "pool" of 100 lay counsellors from all fields of engineering and science will be provided by the Affiliate Council.

Bell Labs Names 20 Winners of University Graduate Fellowships

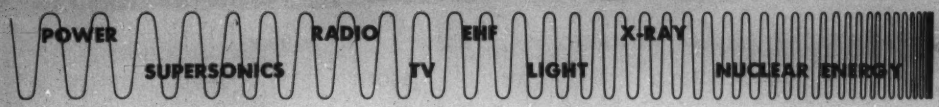
Bell Telephone Laboratories, research and development organization of the Bell System, has announced the names of 20 recipients of its 1957-58 college fellowships. Established in 1955, the grants go to outstanding students pursuing graduate studies leading to Ph.D. degrees in engineering and physical sciences.

Each fellowship carries a grant of $2,000 to the fellow and an additional $2,000 to cover tuition, fees, and other costs to the institution where he elects to study.

Recipients of the fellowships may pursue various branches of mathematics, physics, chemistry, and engineering. Eight of the winners this year will do advanced study

Courtesy John Kroll

STUDENT GUIDANCE MANUAL is presented by B. J. Drummond, chairman of the Michigan Section Student Guidance Committee, to F. J. Meno, 2nd, chairman of the Affiliate Council of the Engineering Society of Detroit, at a meeting held February 7, 1957. At the presentation were: (left to right) Glenn Coley, chairman, Affiliate Council Student Guidance Committee; Mr. Meno; F. G. Horton, managing director, Engineering Society of Detroit; L. Lipkin, vice-chairman, Michigan Section Student Guidance Committee; Mr. Drummond; and E. J. Abfalter, Michigan Section Student Guidance Committee.



in electrical engineering. Physics is the chosen field for five and physical chemistry for three. Two are graduate mathematics students, one is studying engineering mechanics and another mathematical physics. The 20 winners will study at 15 universities across the country.

In 1956, the first year the grants were awarded, 15 fellows were named. For 1957 the number of awards has been increased to 20, to include four previous recipients who are completing their work for Ph.D. degrees. They are: D. G. Dow, Palo Alto, Calif., Stanford University; H. R. Leland, Wausau, Wis., University of Wisconsin; J. E. Mercereau, Pasadena, Calif., California Institute of Technology; and I. W. Sandberg, Brooklyn, N. Y., Polytechnic Institute of Brooklyn.

Other fellowship winners, their home towns and the colleges where they will study are: B. R. Baker, Eldon, Iowa, Stanford University; P. A. Bello, Mattapan, Mass., Massachusetts Institute of Technology; W. B. Bridges, Inglewood, Calif., University of California; Hsu Chang, Taipei, Formosa, Carnegie Institute of Technology; N. R. Draper, Southampton, England, University of North Carolina; D. R. Fredkin, New York, N. Y., Princeton University; S. H. Glarum, Wyncote, Pa., Brown University; W. H. Jones, Jr., Newark, Del., University of Delaware; W. L. Kilmer, Wellsboro, Pa., University of Michigan; K. L. Kotzebue, San Antonio, Tex., Stanford University; Eugene Levine, Brooklyn, N. Y., New York University; Bede Liu, New York, N. Y., Polytechnic Institute of Brooklyn; James McKenna, Lebanon, N. H., Princeton University; W. A. W. Mehlhop, Hamburg, Germany, Washington University at St. Louis, Mo.; W. H. Orttung, Narberth, Pa., University of California; and Sukeyasu Yamamoto, Tokyo, Japan, Yale University.

National Science Foundation Invites Proposals for Institutes

The National Science Foundation (NSF) announced recently that it will accept proposals for support of summer institutes in 1958 and academic-year institutes during 1958-59. The institute program of the NSF is designed to help teachers of science and mathematics improve their subject matter knowledge and their teaching capabilities. The current NSF program will support a total of 96 summer institutes this year, and 16 academic-year (1957-58) institutes in colleges and universities throughout the United States.

Academic-year institutes will offer full-time work during the regular school year 1958-59 in the subject matter of the sciences and mathematics, designed especially for the needs of secondary-school teachers in those fields. The NSF will support attendance of secondary-school teachers as well as dependency, book, and travel allowances. Tuition and fees and support of other operating costs of the institute may also be requested in the proposals submitted.

Summer institutes also offer work in the subject matter of the sciences and mathematics especially designed for teachers. Proposals may be presented which are designed for the special needs of high-school teachers, college teachers, or science supervisors. Foundation support may be requested for stipend, dependency, and travel allowances, tuition and fees, and other operating costs of the institute.

Directions for preparing proposals, and forms to be used in making application may be obtained by interested institutions of higher education from the Division of Scientific Personnel and Education, National Science Foundation, Washington 25, D. C. Deadlines are August 1, 1957, for submission of proposals for institutes to be held in the summer of 1958; September 1, 1957, for proposals for support of academic-year institutes during 1958-59.

"Traveling Science Teachers" Selected for 1957-58 School Year

The Oak Ridge Institute of Nuclear Studies (ORINS), Oak Ridge, Tenn., has announced the selection of 10 new "traveling science teachers" for the 1957-58 school year.

The 10 are the finalists selected from 287 applicants to participate in the second Oak Ridge Traveling Science Demonstration Lecture Program, sponsored jointly by the National Science Foundation and the U. S. Atomic Energy Commission (AEC) and administered by ORINS.

After three months of special training at ORINS, including attendance at a one-month institute for secondary-school science teachers, the 10 newly appointed teachers will journey about the country visiting high schools and presenting lecture-demonstrations before hundreds of science classes during the school year that starts in September 1957.

Faculty members of the schools to be visited may choose from a variety of topics as subjects for the demonstration-lectures, and will be encouraged to take an active part in planning and carrying out the activities. The list of topics includes atomic structure, radioactivity, nuclear reactors, solar energy, space travel, opportunities in science, and many others.

This program is especially designed to stimulate interest and competence in science and science teaching, and to encourage teachers and students to construct or acquire low-cost demonstration apparatus. In each of the vehicles in which the teachers travel will be more than 800 pounds of demonstration equipment, most of it designed and built by the teachers themselves and easily duplicable from inexpensive materials.

In addition to presenting classroom demonstration-lectures at a different high school each week, each teacher will also be available for discussions and conferences with faculty members, science clubs, and other professional groups to exchange ideas on methods of improving the teaching of science subjects. Each of the 10 teachers will travel in an assigned territory, and it is expected that more than 300 schools will be visited during the school year.

The seven traveling teachers who inaugurated this unique program in 1956-57 returned to Oak Ridge at the end of May to make a detailed report and evaluation of the program, and to suggest possible improvements for the 1957-58 program. The first group traveled in station wagons provided by the Ford Motor Company; gas and oil for the vehicles was provided by the Gulf Oil Corporation.

The 10 teachers selected for the 1957-58 school year are J. P. Hindman, Casa Grande Union High School, Casa Grande, Ariz.; E. H. Hoffart, York High School, York, Nebr.; K. V. Jackman, The Hill School, Pottstown, Pa.; J. E. Jines, Santa Fe High School, Santa Fe Springs, Calif.; Woodrow Light, Gordon Military College, Barnesville, Ga.; D. W. Mayes, Bald Eagle–Nittany High School, Mill Hall, Pa.; H. P. Pluimer, Renville Public Schools, Renville, Minn.; T. J. Ritzinger, Rice Lake High School, Rice Lake, Wis.; W. B. Sanford, Painted Post High School, Painted Post, N. Y.; and E. C. Spafford, Stockton College, Stockton, Calif.

Case Receives Grant for Closed Circuit Television

A grant of $16,500 has been awarded Case Institute of Technology by the Ford Foundation Fund for the Advancement of Education extending support for experimental two-way closed circuit television as a teaching aid.

Case Institute will continue its work now in progress using the two-way closed circuit television in the electrical engineering department. J. R. Martin, associate professor in electrical engineering is directing the research project, which eventually will be expanded to include the entire Case Institute campus.

Prof. Martin joined the Case faculty as an instructor in 1920, after receiving his bachelor's degree from Illinois College. He received his master's degree in physics from Case six years later and was promoted to assistant professor.

In 1931, Prof. Martin transferred to the electrical department where he established

and developed the first courses in communication and electronics to be offered at the school. During World War II, he established courses in pre-radar training at Case and developed the same program for U.S. Army and U.S. Navy officer training.

Professor Martin currently is in charge of courses in network theory, communications, radio engineering, and microwave engineering. He is a consultant for Thompson Products, Inc., Cleveland, Ohio, and is a member of several honorary and professional societies.

Television already has proved itself a valuable tool for instructing large classes, or separate classes in different rooms., (*Electrical Engineering*, March 1956, pp. 307-8). The closed circuit setup permits more detailed teaching methods and the use of large-scale equipment such as giant computers, nuclear energy devices, astronomical telescopes, and others.

Use of television is expected to increase greatly as a teaching method in coming years, especially in technological education where increased enrollments and faculty shortages hamper the desired close teacher-pupil relationship.

Prof. Martin is being assisted by a psychologist and a statistician in drawing up educational measurements for evaluating the success of the program. The experiments are being conducted in standard Case classes with regularly assigned instructors using the equipment.

Dr. C. H. Faust, president of the Ford Fund, made the announcement of the grant. A total of $493,230 has been awarded to 27 schools for educational experiments aimed at placing more responsibility upon the student for his education, improving curriculum, developing teaching resources, and extending the reach of colleges through television and films.

Career Conference Held at Illinois Institute of Technology

The increasing interest in science and engineering is reflected in attendance figures from the ninth annual Chicago Area Career Conference.

One third of the total attendance at the conference—held March 30 at Illinois Institute of Technology—was recorded in panels dealing with engineering and physical and biological sciences.

The conference is sponsored annually by Illinois Tech, the Chicago Technical Societies Council, and the Chicago *Sun-Times*.

A total of 1,359 high school and junior college students attended the all-day conference, representing a 50% increase in attendance over the previous year.

The students chose from a field of eight panels offered during each of the four periods scheduled throughout the day. Some attended only one panel, whereas others were present at two or more.

Total attendance at all 32 panels was 4,090, with 1,367 at sessions on engineering and science. Of this number, 739 were interested in engineering, 458 in physical sciences, and 170 in biological sciences.

Other panels attracting large numbers of students were: professional entertainment, 220: medical services, 211; psychology, 210; journalism, 208; elementary teaching, 162; art, 155; nursing, 155; and secondary teaching, 154.

Panel discussions also were held on such varied subjects as music, graphic arts, merchandising, trades, secretarial, library science, and home economics.

Of the 1,359 who attended the conference, 740 were boys and 599 girls. Twenty adults also attended. More than 170 schools were represented, including public and private elementary schools, high schools, junior colleges, and universities.

High school students attended from Indiana and Wisconsin, and one came from Waipahu, Oahu, T. H. College students, representing 28 institutions, attended from as far as Brockport State College, N. Y., and Pomona College, Calif.

Prof. Torgersen Named Dean of School of Engineering at U. of C.

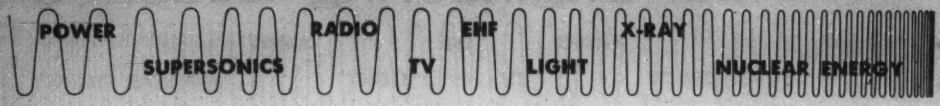
Prof. Harold Torgersen (M '39), associate dean of New York University (NYU) College of Engineering has been appointed dean of the University of Connecticut's (U. of C.) School of Engineering, President A. N. Jorgensen of the U. of C. announced recently.

The new dean will direct work of the present departments of mechanical, electrical, civil, and mechanical-industrial engineering and will supervise the development of the new departments in chemical and aeronautical engineering.

"The university's School of Engineering

Outstanding Graduating Senior

W. P. BLISS, senior in electrical engineering at the University of Arizona College of Engineering, was picked as the "Outstanding Graduating Senior of the Year." He received the B.S. in E.E. degree at the university's 62nd Annual Commencement Exercises on May 29, 1957. Recipients of this award, which is presented by the University's Chi chapter of Theta Tau, national professional engineering fraternity, are picked by the UA Engineers Council. This is made up of representatives of each of the engineering classes and of the student chapters of the AIEE, Institute of Radio Engineers, American Society of Mechanical Engineers, American Society of Civil Engineeds, and the American Institute of Mining, Metallurgical, and Petroleum Engineers.



has been developing important contacts with Connecticut's industries, both in training of personnel and in research contributions," President Jorgensen said. "Dean Torgersen's wide experience in these fields is expected to foretell a considerable increase in the University's services in these directions."

A cum laude graduate of NYU's College of Engineering in 1929, with subsequent graduate study at the University of Wisconsin, Columbia University, and Harvard, Dean Torgersen holds an M.S. degree from Harvard and is a licensed professional engineer in New York State.

He has also been active in the organization of educational programs in the field of nuclear engineering.

He served in the U. S. Navy from 1941 to 1946, heading the electronics department of the U. S. Naval Postgraduate Communications School, and is a commander in the U.S. Naval Reserve (Ret.). He also was a test engineer with the General Electric Company and for some years was a consultant in designing power plants.

Prior to appointment as associate dean at NYU, he directed the Evening Division of NYU's College of Engineering.

Dean Torgersen is a member of the Engineering Manpower Commission of the Engineer's Joint Council, the Military Affairs Committee of the American Society for Engineering Education, the Staten Island Historical Society, and the Norsemen's Federation.

The new dean, who is also a professor of electrical engineering at NYU, is expected to assume his duties at the U. of C. late this summer. He succeeds the former dean, the late F. L. Castleman, Jr.

ORINS Announces Award of 117 Nuclear-Energy Fellowships

The Oak Ridge Institute of Nuclear Studies (ORINS) has announced the award of 117 special fellowships in nuclear energy technology for the academic year 1957-58—the first in this new program which ORINS administers for the U. S. Atomic Energy Commission (AEC).

The purpose of the program is to encourage more students at the graduate level to pursue courses of study in the physical sciences and nuclear-energy technology, with particular emphasis on reactor development.

The 117 fellows were selected for their outstanding academic achievements from more than 300 applicants. Final decision was made by a board composed of representatives of the AEC, educational institutions, industry, and ORINS.

The new fellowship program is part of the AEC's general program of assistance in the field of education for the purpose of alleviating the shortage of trained nuclear scientists and engineers. The AEC has approved proposals from 28 universities and colleges for participation in the program, and additional proposals from other institutions for participation at a later date will be considered.

A broad curriculum outline has been prescribed for the nuclear-energy fellows, designed with sufficient flexibility to permit the university to which each student is assigned to determine his particular course needs, within the minimum subjects of study to be covered. The fellowships are awarded for one year of study, and carry a basic stipend of $1,800 with additional allowances for dependents, tuition, and travel.

Engineering Seminars at Pennsylvania State University

Seminars in 10 different fields of engineering will be held during the coming months on the campus of The Pennsylvania State University, University Park, Pa.

The programs are intended to furnish engineers, scientists, and industrial managers with concentrated advanced study not readily available to those wishing to keep abreast of the most recent developments in science and technology.

The seminars, offered by the University's College of Engineering and Architecture, are:

Automation: June 9-14, an intensive seminar on the latest techniques related to automation equipment development for manufacturing and design engineers responsible for the design, installation, and operation of such equipment for automated production.

Electrical Contacts: June 9-14, on the fundamentals and applications of electrical contacts, including small group discussions of specific problems.

Digital Computers: June 9-14, to include a discussion of limitations of digital computers for industrial use, an explanation of planning problems for solution by electronic equipment, a brief description of some industrial problems which already have been solved, and a survey of existing commercial computers.

Nuclear Power Cycles: June 9-14, dealing with thermodynamic problems arising from the use of nuclear reactors as energy sources in power generation cycles. The seminar will be concerned primarily with the effects which the characteristics of reactor heat release and control have on cycle design and operations, not with the reactor.

Creative Engineering: June 16-21, to provide information on procedures and principles which can assist in the production of new and fruitful ideas, with emphasis on techniques, business machines, product design, imaginativeness, growth in industry, mechanical devices in a chemical plant, and training in a creative engineering program.

Electrostatic Precipitation: June 16-21, primarily for engineers in public utilities and in various industries who are concerned with the operation of electrostatic precipitation equipment.

R & D Management Development: July 7-12, designed for research and development project leaders who, through technical competence, are placed in positions of supervision and administration.

Underwater Missile Engineering: July 7-19, a lecture and practical course at the graduate level to offer a broad introduction to underwater missile engineering and to serve as a practical case study of the application of the systems approach to the solution of over-all guided missile design problems.

Technical Report Writing: September 15-27, to provide scientists and engineers with practical instruction and supervised practice in the preparation of effective technical reports, and to furnish technical writers and editors with a comprehensive refresher course.

Electric Utility Systems: October (date not set), to provide a discussion and demonstration of the many facets of electric utility engineering and operation, aimed at department heads, division heads, and junior executives of all departments of electric public utilities.

Inquiries should be directed to T. R. Ferguson, Extension Conference Center, The Pennsylvania State University, University Park, Pa. Detailed announcements will be available in the near future.

Excellence in Teaching Awards Go To Four MIT Graduate Students

Awards of $500 each for "excellence in teaching" have been made to four young graduate students in the department of electrical engineering at the the Massachusetts Institute of Technology (MIT) by Dean of Engineering C. R. Soderberg.

The new teaching awards in electrical engineering at MIT have been established through a grant from the Television Shares Management Corporation to help defray the expenses of graduate study of students who are working for advanced degrees and who have demonstrated both interest and proficiency in teaching.

The recipients, all of whom intend to enter the teaching profession, are E. P. Gyftopoulos, Athens, Greece; D. R. Whitehouse, Cambridge, Mass.; W. A. Youngblood, Mart, Tex.; all instructors in electrical engineering, and T. G. Stockham, Jr., Upper Montclair, N.J., a teaching assistant in electrical engineering.

"In view of the growing critical need for

qualified teachers in all fields of engineering," said Dean Soderberg in commenting on the awards, "Television Shares Management Corporation is to be congratulated for establishing a means of giving support and recognition to teaching achievement.

"The recipients, in their turn, are to be congratulated for having demonstrated promise of success in the field of teaching and for their high level of achievement in their graduate studies."

Trans-Sonics, Inc., Institutes Tuition-Aid Plan at Northeastern

A new tuition-aid program has been instituted at Northeastern University by Trans-Sonics, Inc., of Burlington, Mass., for employees desiring to further their education, Northeastern's President C. S. Ell has announced.

Under this program, Trans-Sonics employees will be reimbursed for expenses incurred for taking courses of instruction in either the College of Engineering, School of Business, or Lincoln Institute. The student must satisfactorily complete the courses and still be in the employ of the company at the time of termination of the study program.

The program also provides for payments to Northeastern equal to tuition charges, plus a small amount to cover the administrative costs.

Trans-Sonics, Inc., a company making precision instruments for aircraft, is one of many companies which assists its qualified personnel in getting further educational instruction.

Employees currently enrolled at Northeastern are also eligible for benefits under the new program.

Program of Educational Grants Expanded by Cleveland Company

The Cleveland Electric Illuminating Company has announced an expansion of its program of financial grants to colleges and universities.

The company has inaugurated a program to encourage its employees to support those colleges and universities in which they have a special interest. Through its Corporate Alumnus Program, the Illuminating Company will make a contribution equal to that of any of its employees (up to $500 a year) to any accredited college or university in the United States.

In the first two months of the year, contributions from employees to colleges and universities totaled $700. Since The Illuminating Company matches this figure, a total of $1,400 has gone to institutions under the company's Corporate Alumnus Program. The contributions were made by 11 employees. The program started January 1, 1957.

"For years the company has made grants to educational institutions in the belief that a strong educational system is vital to the existence of the American free enterprise system," said E. L. Lindseth, president of the company. "Our company recognizes and accepts its responsibility for the support of many of the nation's colleges and universities."

In general, company contributions will favor those institutions and programs which prepare employees and others in fields of knowledge pertaining to the electrical industry, Mr. Lindseth indicated. "It should be recognized however," he said, "that the electrical industry serves all the arts, all the sciences, and all the humanities."

It was stated that requests for special assistance in such areas as scholarship aid, teachers' salaries, research programs, special endowments, etc., are welcomed and will be considered in the light of their special benefit to the company and the communities it serves. Applications from colleges and universities in the company's service area are honored first.

Applications, which must be made in writing, are reviewed by the Illuminating Company's Committee on Subscriptions—a group of executives and a permanent secretary—which meets each month to analyze and evaluate all current requests.

Nuclear Energy Courses Offered to Faculty Members

L. L. Strauss, chairman of the Atomic Energy Commission (AEC), announced that the AEC will sponsor summer institutes in nuclear energy technology for university faculty at five AEC facilities in 1957.

Approximately 150 faculty members will attend the sessions at the Brookhaven, Argonne, and Oak Ridge National Laboratories. The Ames Laboratory, and The Hanford Plant. Each institute will be conducted by the staffs of AEC contractors for a period of two months.

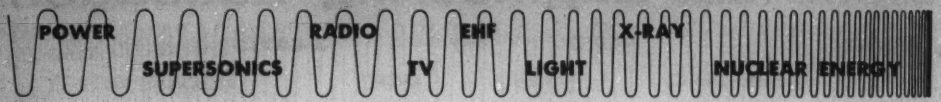
Basic courses in nuclear energy technology will be offered at the Brookhaven National Laboratory. The curricula will include reactor physics, chemistry and chemical engineering, reactor materials and metallurgy, and reactor instrumentation and controls.

The courses offered at the other tour

Engineering Week Exhibit

CELEBRATION OF ENGINEERING WEEK at the University of Pittsburgh, March 18-22, gave undergraduates and visiting high school students their first look at some of the actual mechanics involved in producing nuclear reactor fuel. The exhibit, used as a visual aid to help demonstrate and explain the theme "You and Engineering," was a scale model of the extraction section of a new $40 million reactor feed-materials production plant. The model was displayed by Blaw-Knox Company, Chemical Plants Division, Pittsburgh, Pa., who designed and engineered the plant for the Atomic Energy Commission (AEC). The new plant incorporates advanced processing methods devised by Mallinckrodt Chemical Works, operator for the AEC.

Electrical Engineering Education



AEC installations will be of a more advanced and specialized nature. Each will require advanced technical education comparable to that gained from participation in the institutes held last summer at the Brookhaven and Argonne National Laboratories, or the equivalent in work experience. Subject matter to be included in each of the four institutes is as follows: Argonne National Laboratory, Lemont, Ill.—training program in the operation of the training reactor Argonaut; Oak Ridge National Laboratory, Oak Ridge, Tenn.—advanced reactor theory; Ames Laboratory, Ames, Iowa—advanced nuclear metallurgy; and Hanford Plant, Hanford, Wash.—advanced chemical processing (a "Q" Clearance is required for participation in the Hanford course).

The AEC will provide cost-of-living stipends up to $750 per faculty member, matching amounts provided by each participant's academic institution, and will defray travel expenses. These funds will be administered by the American Society for Engineering Education (ASEE). No tuition will be charged.

The ASEE will also co-operate with the AEC in the selection of faculty to attend the institutes. Inquiries concerning enrollment may be addressed to: W. L. Collins, Executive Secretary, American Society for Engineering Education, University of Illinois, Urbana, Ill.

United States Steel Foundation Announces Grants to Education

The United States Steel Foundation (USSF), Inc., has announced a program of aid-to-education with grants payable in 1957 totaling nearly $1.8 million to over 600 of the nation's privately supported liberal arts colleges, universities, technological institutes, and medical schools.

In making the announcement, R. M. Blough, chairman of the board of trustees of the USSF, said: "The action of the Trustees represents an effort by this Foundation to extend aid in some form to almost every voluntarily supported institution of higher learning which has clearly demonstrated both its desire and ability to help itself through the crisis presently facing higher education."

The USSF's seven-part program embraces the following:

Accredited Liberal Arts Colleges—$500,000. Unrestricted operating aid to all the 430 accredited four-year member colleges of all the national, state, and regional college fund-raising groups. Similar aid direct to 70 other selected institutions unaffiliated with those groups.

Nonregionally Accredited Liberal Arts Colleges—$100,000. Operational and capital-aid grants, to be administered through the Association of American Colleges, to a number of colleges not yet fully accredited, but seeking to provide greater community service.

Universities and Engineering Institutes—$110,000. Operational aid of an unrestricted character for 55 major private universities and engineering schools throughout the nation.

Medical Schools and Medical Teaching—$190,000. Operational assistance of $65,000 for all 82 medical schools and the balance for two capital-facility grants for medical teaching centers to enhance and strengthen their programs.

Postgraduate Study Fellowships—$150,000. Continuation and expansion of the Foundation's present doctoral level graduate study program covering the humanities, social sciences, biological and physical sciences, and engineering, with grants and allotments equally divided between public and private institutions.

Project Grants in Aid of Education—$70,000. Previous project grants were continued and new ones were added, including provision for the Commission on Colleges and Industry of the Association of American Colleges, the Council for Financial Aid to Education, the Institute for International Education, the Association of College and Reference Libraries, and a project for stimulation of alumni giving.

Major Capital Grants. Authorization of $665,000 for payment in 1957 and, additionally, commitments of $525,000 payable in later years, for endowment, building, equipment, and other facility needs of 16 outstanding universities, liberal arts colleges, women's colleges, engineering schools, and other institutions.

"It is the hope of the Trustees," Mr. Blough continued, "that their course of action will encourage others—according to their interests and abilities—to increase substantially the present level and scope of assistance to higher education. Adequate means must be found for meeting the needs of institutions, if both quality and quantity educational goals are to be balanced with the requirements of a rapidly expanding nation."

Bell Telephone Laboratories To Provide College Tuition Aid

A college tuition aid plan has been established by Bell Telephone Laboratories to assist its employees in furthering their education. This provides a maximum of $250 in tuition per school year for undergraduate studies which employees pursue on their own time.

Announced by Dr. M. J. Kelly, president of Bell Laboratories, the plan is available to all regular full-time employees. The courses elected under the program must be ones for which the college grants credit toward a degree and must be of benefit to the employee's work.

Full tuition, up to $250, will be refunded by Bell Laboratories to each participating employee. One half the tuition will be paid at the start of the course and the other upon its successful completion.

Bell Laboratories for many years has provided employees with a variety of opportunities for education and training. Educational assistance for graduate study is available through tuition refunds and also through company training courses on a graduate level. At the undergraduate level, there is already both in-hour and out-of-hour training programs covering a wide range of subject matters.

This tuition aid is being extended to those interested in outside undergraduate study wherever this promises to contribute to the employee's effectiveness on the job. It is felt that this support of undergraduate study is a substantial step forward in developing to the maximum the capabilities of Bell Laboratories people.

Austin Company To Design Case Industrial Nuclear Center

A contract for the design and engineering of the Case Industrial Nuclear Center has been awarded to The Austin Company of Cleveland, Ohio, according to an announcement made by Dr. T. K. Glennan, president of Case Institute of Technology.

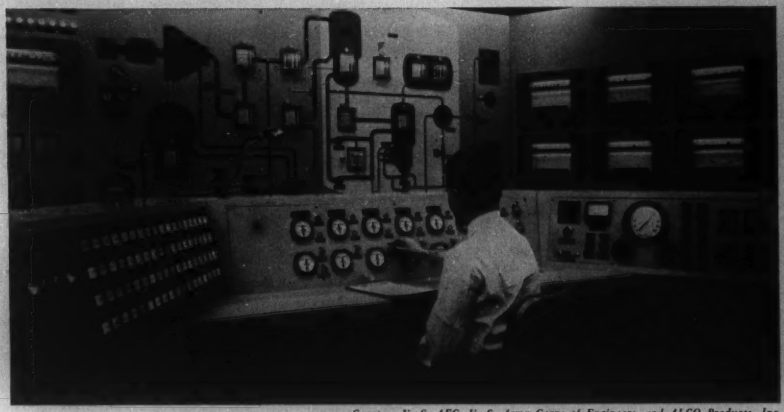
Dr. Glennan said that Austin engineers have been authorized to proceed with preliminary designs for the center, which is being planned under the joint sponsorship of Case and industrial firms interested in types of research which require a high flux engineering test reactor.

The Austin Company has had a prominent role in the planning and erection of more than $100 million worth of facilities for the Atomic Energy Commission (AEC) in addition to its work on nuclear facilities for private industry and would handle all building aspects of the Case project.

It is one of the original members of the study group which has been investigating the feasibility of building and operating a nuclear research and development center of this type in the Cleveland region. The other participants include: The Cleveland Electric Illuminating Company; Republic Steel Corp.; Schenley Industries, Inc.; Standard Oil Company of Ohio; and Thompson Products, Inc.

E. J. Goodheart, Austin's manager of nuclear projects, will head engineering development of the Case nuclear center as Austin's project manager. With a site of several hundred acres near Cleveland, still to be selected, it is estimated that the project will cost approximately $7 million.

OF CURRENT INTEREST



ARMY Package Power Reactor is operated from this station in the control room, where a nuclear engineer observes all functions as they are read and recorded on the instruments.

Courtesy U. S. AEC, U. S. Army Corps of Engineers, and ALCO Products, Inc.

Army Package Power Reactor Produces 2,035-Kw Gross Output

THE ARMY Package Power Reactor (APPR) is a 2,035-kw pressurized-water nuclear electric generating plant built at Fort Belvoir, Va., by ALCO Products, Inc., under contract to the U. S. Atomic Energy Commission (AEC) for the U. S. Army. It is the Army's first undertaking in the power reactor field. The net electrical output of the plant will be utilized to supplement the Fort Belvoir power distribution system.

The original design study by the Oak Ridge National Laboratory (ORNL) was for a reactor to meet needs of remote military bases. Certain design requirements were modified to adapt the APPR to permanent construction in a populated area of the United States.

The APPR has a net power output of 1,855 kw. Of the total 2,035 gross output, 180 kw are required for plant auxiliaries. The APPR could provide power for a community of 2,000. Although electric power has been produced by several other AEC reactors, this plant is unique in several ways.

The pressurized-water concept has been proved in the submarine *U.S.S. Nautilus*, which has logged thousands of miles of operation on its nuclear power plant. The APPR design also has undergone zero-power tests at ALCO's Criticality Facility, Schenectady, N. Y. Tests of APPR components performed at the facility are credited with having trimmed about six months off the estimated completion time of the Fort Belvoir installation.

In general, operation of the plant can be divided into two systems—primary and secondary. The principal difference from a conventional power station lies in the primary system, where nuclear reaction replaces conventional fuels as the means of heating the water. Components in the APPR's secondary system closely approximate, on a smaller scale, those employed in a power generating plant using conventional fuel.

Primary System

The reactor core consists of 38 fuel rods and 7 control-rod assemblies fabricated by the ORNL. The core and its supporting structure are housed in the stainless-steel-clad reactor vessel built by ALCO. The vessel measures 47½ inches inside diameter and 162 inches over-all length and is clad with 0.125 inch of stainless steel on all surfaces in contact with primary water.

The fully enriched, uranium dioxide fuel is incorporated into flat-plate type elements. Each fuel assembly consists of 18 fuel plates brazed into a pair of 304L stainless steel side plates 27 inches long, 2.863 inches wide and 0.050 inch thick. The outside plates are 27 inches long, and the internal plates are 23 inches long. Each assembly has on both ends a 304L stainless-steel grid adapter, or end box, attached by fusion welding.

The control rods consist of a fuel section and an absorber section. Control-rod fuel plates are fabricated in the same manner as the stationary fuel plates, but are 23 inches long, 2.56 inches wide, and 0.03 inch thick. The absorber section is boron enriched in the isotope boron-10.

The steam generator has a U-type tube bundle with 326 tubes each ¾ inch outside diameter by 0.062 inch wall, with a total effective heating surface of 836 square feet. Inside the same shell, separated from the generating section by a baffle plate, is the superheater section, with 194 square feet of heating surface. Hence, the total heating surface of the generator is 1,030 square feet.

The steam generator receives slightly radioactive water at 450 F from the primary system, while secondary water at 250 F enters the shell side about halfway up the steam-generating section at a full-load rate of 34,270 pounds per hour. The secondary water is converted to steam by contact with the tube bundle, which contains the heated primary water, thus driving the turbine downstream in the secondary side of the plant.

Water in the primary system is thoroughly purified to protect against corrosion. The primary system contains about 1,300 gallons of water which is circulated at a rate of about 4,000 gpm (gallons per minute). This water is maintained at a total solid concentration of not more than 2 ppm (parts per million).

Portions of water in the primary loop are removed and purified in two demineralizers, each 42 inches high, 12 inches in diameter, and containing about 2 cubic feet of resin. When the water leaves the demineralizers, it contains no more than 0.5 ppm of total solids. After passing through a micrometallic filter, it enters a 5,000 gallon stainless steel primary-water tank for recirculation to the primary loop.

The primary shield is a 156-inch diameter steel tank filled with water and containing eight concentric steel cylinders. Each cylinder is 2 inches thick and the cylinders are separated by an inch-thick layer of water. The innermost cylinder also functions as the inner wall of the tank and as a support for the pressure vessel. An iron-water shield was selected because it weighs less, is smaller than an equivalent concrete shield, and permits faster fabrication on the site.

The secondary shield—5 feet of concrete—was designed so that the dose rate will be less than 1.5 mr (milliroentgens) per hour at any point outside the vapor container at building level. This dose rate is much less than allowable laboratory tolerance. Two feet of the secondary-shield concrete are inside the vapor container wall, with an additional 3 feet on the outside of the container shell from ground level to a height equal to that of the control room roof.

Secondary System

A Hagan three-element regulating valve is provided in the feedwater connection to the steam generator. Close regulations of conditions in the steam generator and the secondary system in general is maintained by adjusting the blow-down.

The steam from the steam generator is channeled to the turbine, which has a maximum capability of 2,500 kw. The turbine drives a 2,500-kva generator through a reduction gear at a speed of 1,200 rpm. The generator produces three-phase, 60-cycle current at 4,160 volts. Excitation is from a 15-kw direct connected exciter. This turbine generator set is capable of converting the total available normal heat output of the steam generator to electric power.

The Lummus condenser has a two-pass, divided water box, single tube-sheet arrangement. Tubes are sealed to the tube sheet with 50/50 solder and then rolled into serrated tube-sheet holes. Serration provides exceptional joint strength, as well as a labyrinth seal between tubes and tube sheet, to prevent leakage of circulating water into the secondary system.

The APPR uses one low-pressure feedwater heater operating at system design of 29.9 psia (pounds per square inch, absolute). The effect of the heater is to produce a higher thermal efficiency in the cycle. Heat is channelled to the feedwater heater from a steam-bleed point in the turbine.

The strong negative temperature coefficient of the APPR makes it a very stable system, and instrumentation and controls were designed to take full advantage of this stability. With the temperature coefficient at least -2×10^{-4} per degree Fahrenheit, no additional control mechanism is needed to override rapid transients or power excursions.

Start-up of the APPR is manually controlled in co-ordination with indications from electronic pulse-counting channels. Two instrument channels monitor the neutron flux from the source level to an intermediate range of power to insure safety in start-up. Detectors in these channels are the boron trifluoride and fission chamber types. Compensated ionization chambers serve as the detecting elements for neutron flux covering power levels from intermediate range to 150% of rated plant power. Three identical ion-chamber channels are provided in the safety circuit. These have the main function of "scramming" the reactor if it should reach unsafe levels.

Scramming is accomplished by release clutches holding the control rods out of the reactor core during operation. The clutches are released electronically, and very rapidly, in response to high neutron flux level, and the rods drop by gravity, thereby inserting the boron poison that shuts down the reactor.

A final, period channel is provided to prevent dangerous runaways. This channel, instead of merely responding to the absolute power level or neutron flux, responds to the rate of increase of power level and scrams the reactor when that rate reaches abnormally high values.

General Features

It is the first complete integrated generating plant using the pressurized water concept, as well as the first power reactor using stainless steel clad fuel, with light water as the coolant and moderator.

In addition to opening a new chapter in the military application of nuclear energy, the APPR helps set the foundation for future civilian uses of the relatively new power source.

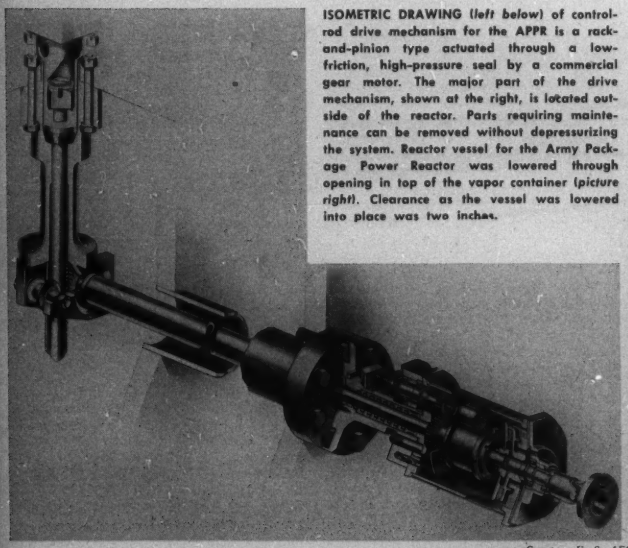
Just as the AEC and the Army expect to develop smaller reactors as power sources in remote areas, similar civil uses are reaching the stage of practicality in areas where conventional fuel is a supply problem.

FM Signals Sent as "Radio Pill" Passes through Body

A DEMONSTRATION of a "radio pill" that sends out FM signals to medical researchers as it passes through the human body was given for the first time at the Rockefeller Institute recently.

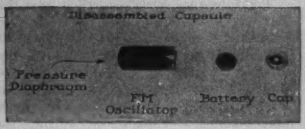
Designed for research in the intestinal tract, the new "pill" is a plastic capsule $1\frac{1}{4}$ inches long and $\frac{1}{10}$ of an inch in diameter. It is the world's smallest FM radio broadcast station.

The "radio pill" has been developed and tested jointly by the Rockefeller Insti-



ISOMETRIC DRAWING *(left below)* **of control-rod drive mechanism for the APPR is a rack-and-pinion type actuated through a low-friction, high-pressure seal by a commercial gear motor. The major part of the drive mechanism, shown at the right, is located outside of the reactor. Parts requiring maintenance can be removed without depressurizing the system. Reactor vessel for the Army Package Power Reactor was lowered through opening in top of the vapor container** *(picture right)***. Clearance as the vessel was lowered into place was two inches.**

Courtesy U. S. AEC, U. S. Army Corps of Engineers, and ALCO Products, Inc.



RESEARCH "radio pill," shown approximately half size, has world's smallest FM radio broadcast station comprised of a transistor oscillator the frequency of which is modulated by fluctuations of fluid or gaseous pressures in the intestinal tract.

ANTENNA at end of long metal rod (*foreground*) picks up FM signal from "radio pill" swallowed by patient. As "pill" passes through the human body, pressure changes are indicated on cathode-ray oscillograph (*right*). Dr. V. K. Zworykin (*left*) holds bottle containing a "radio pill" and observes oscillograph's wavy line with Dr. J. T. Farrar.

tute, the New York Veterans Administration Hospital, and the Radio Corporation of America (RCA). It was designed by Dr. V. K. Zworykin, honorary vice-president of RCA and affiliate in biophysics in the Medical Electronics Center of the Rockefeller Institute, and his associates, as it had been envisioned by Dr. J. T. Farrar, chief of the Gastroenterology Section of the New York Veterans Administration Hospital and assistant professor of clinical medicine at the Cornell University College of Medicine. The "pill" was developed by engineers of RCA's Commercial Electronics Products unit in Camden, N. J.

The "radio pill" seems to offer many possibilities as an important new tool in medical research. It can be swallowed like any other medicinal capsule without discomfort, and will permit measurements on internal organs with minimum psychological and physical disturbance to normal bodily functions. It is hoped that the pill will prove valuable in studying human digestion and absorption in normal and pathological states. The new information which may be obtained on the physiology of muscular contractions is expected to be important in understanding gastrointestinal disorders; such as, spastic colitis, ulcerative colitis, and other organic and functional disease states. Besides measuring pressure changes in the digestive organs of the body, the "radio pill" is being modified so that it may generate and transmit impulses relating to temperature within the gastrointestinal tract.

The new "radio pill" has several electronic components consisting of a tiny transistor, an oscillator, a ferrite cup inductance core, and other circuit elements; and a minute replaceable storage battery which powers the oscillator and has a life of 15 hours. This battery is similar to the one used in the famous proximity fuse for anti-aircraft shells during World War II.

Heart of the capsule is the oscillator which is so sensitive that its frequency varies with changes in the pressure to which the "pill" is exposed. Information about these pressure changes is transmitted continuously in the form of FM radio signals that carry for a distance of several feet. These signals can be picked up on an outside FM radio receiver when an antenna is held close to the body. They can be recorded on one or more of three instruments: a meter, a recording galvanometer which makes a permanent record of wavy lines on paper much like an electrocardiograph, and a cathode ray oscillograph similar in principle to the picture tube of a home television set.

When the "pill' is swallowed by the patient, its course through the gastrointestinal tract can be traced by fluoroscopy or other means. Because it has magnetic properties, it can be manipulated by magnetic forces outside the body. The capsule can be recovered and re-used in later experiments.

Studies involving use of the "radio pill" are carried out in the New York Veterans Hospital, for the time being at least, with the patient under continuous observation. In its present stage, the "pill" is an experimental technique. Its commercial possibilities will be evaluated following further extensive laboratory tests and experiments.

Solar Heat and 18,000 Mph Speeds Produced by Devices Developed Recently

HYPERSONIC SHOCK TUBES for industry, universities, and specialized research teams and laboratories will be produced by the Research and Advanced Development Division of Avco Manufacturing Corporation, it was announced recently. The shock tube is capable of duplicating environmental conditions of flight in speed ranges up to 18,000 mph, or 25 times the speed of sound.

It was stated that the tubes will be custom made and installed, based on individual consultation and consignment, to fit the precise requirements of purchasers. A basic shock tube design, proved versatile in research work, is being offered which is made up in 5-foot tube sections for installation flexibility. However, it will be possible to have special shock tubes designed, coordinated and manufactured for organizations having unusual or special requirements.

The tubes are complete installations, functioning with optional instruments such as high speed oscilloscopes, spectroscopes, high speed cameras, and schlieren instrumentation.

The shock tube series were developed in connection with the research and development on the vital nose cone of the ICBM (intercontinental ballistic missile) of the U. S. Air Force, under guidance of the Western Development Division of the Air Research and Development Command.

Extensive research in the fields of hypersonic flow, aerothermodynamics, gas dynamics, physics, and physical chemistry has been in progress ever since the Everett Laboratory was founded two years ago. In April 1956, it was announced that 18,000 mph (Mach 25) and temperatures of 15,000 F ($1\frac{1}{2}$ times the temperature at the surface of the sun) had been achieved in the 100-foot-long tube.

Shock tubes now are being employed for investigation of problems in chemistry and structures, and it is predicted that further applications will be found as their use in industry and science increases.

Basic features and technical data on the shock tubes of particular interest are: (1) standard $1\frac{1}{2}$ inch inside diameter with models having $\frac{1}{4}$ inch and $\frac{1}{2}$ inch wall thicknesses capable of safe operation up to 2,000 psi (pounds per square inch) static pressure and driver pressures up to 10,000 psi; (2) stainless steel construction to minimize effects of corrosion and erosion; (3) bore center reference machining to insure precise matching and interchangeability of

Avco Research and Advanced Development Div. Photo.

CANNON-LIKE device into which man is peering is largest of a series of hypersonic shock tubes. The 100-foot-long shock tube is for studies in high speed, high altitude flight of intercontinental missiles which must be brought back from outer space despite extreme frictional heat.

parts; (4) 10-microinch internal finishes and accurate control of concentricity to minimize wall boundary-layer growth; (5) 32-microinch flange finishes for proper mounting of "O" ring seals; (6) specially designed diaphragms to insure proper diaphragm rupture and smooth expansion; (7) viewing windows for optical observations and recording; (8) glass- and quartz-windowed and end-capped sections adapted for spectrometric studies; (9) glass-wall test sections adapted for electromagnetic measurements; and (10) replaceable test sections for flexibility and free access to models.

Doors Made of Air Eliminate Weather and Drafts

Doorless entrances installed in stores, banks, and office buildings, which do not revolve, pivot, lower or lock and are unseen by the naked eye because they are made of thin air give unobstructed access from the street while fully insulating the interior under all types of weather conditions.

Walking through on a typical winter day you find yourself in a warm room which seems to be open to the cold outside air. A breeze that forms the invisible separating wall between the inside and outside of the building represents a new design and engineering development of the heating and air conditioning industry.

Aerodynamics laws are used in the design of the Doorless Door. The most important step of the design work is the calculation of the quantity of air needed for maintaining the difference in pressure between the inside and outside of the building.

The data required is height and width of the entrance, inside and outside temperatures, outlet velocity of the air, and depth of the air screen. These figures vary with each installation except for the outlet velocity which should never exceed certain set limits.

The slowly moving downward flow of air which forms the Doorless Door acts as an insulating wall. It protects the building interior from all outside weather conditions and effectively replaces the traditional type of door, swinging or revolving. Thus, it alleviates the main entrance of the building of congested customer traffic and permits shoppers burdened with packages to leave or enter through an unobstructed doorway, without shoving or pushing. The Doorless Door is a unique step in increasing shopping comfort.

The Swiss engineering development, created by Sulzer Bros. of New York, is operated by a series of overhead nozzles located in the ceiling grille through which a curved beam of air is sprayed, falling in layers outward and downward. The air sucked through a floor grating that runs the full length of the entrance is carried through a heating or cooling unit (depending upon season) after being filtered and cleaned. It is then moved through ducts to the ceiling and recirculated.

The filters are manufactured so that they catch all dirt, dust, grime, as well as insects—and prevent them from entering the building. Waste papers, cigarette butts, and other small particles are collected in a pit under the suction grating from where they are periodically flushed away. The nozzles are adjustable and the velocity of the ducts can be changed manually or automatically, as the case may be, to meet the variable weather conditions.

Installations throughout the world have proved these doors now in service have: (1) eliminated congestion in moving traffic, (2) eliminated rush hour pile-ups, (3) eliminated revolving door accidents, and (4) reduced insurance costs.

Of equal importance: the completely open entrance effectively creates impulse buying.

Some further advantages of the installations are: (1) reduced loss of heat in winter; (2) reduced loss of cool air in summer; (3) dust and dirt kept away from machines, sales counters, offices, etc.; and (4) to permit freer access to the loading and unloading facilities.

Recent Developments in Polycarbonate Technology

THE DISCOVERY and initial development of a new plastic material tough enough to replace metals in many applications was announced recently by General Electric Company (GE).

Parts made from the new compound, LEXAN (registered trade mark) polycarbonate resin, are reportedly strong enough to withstand the blows of a carpenter's hammer. GE expects LEXAN molding compound to replace cast metals, ceramics, and other plastics in some applications.

It is stated that LEXAN resin offers an unusual combination of toughness, impact strength, heat resistance, and dimensional stability. These properties make it promising for applications not previously handled by conventional thermoplastic materials.

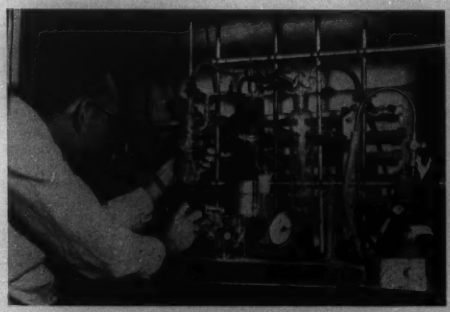
According to the announcement, initial discovery of the polycarbonate polymers which led to the LEXAN development was made at the GE Research Laboratory in Schenectady, N. Y. Further development of the material has taken place in the laboratories of the GE Chemical Development Department in Pittsfield, Mass.

LEXAN resin is now being made in small lots at the company's Applied Research Laboratory at Pittsfield, and all available material is going into the company's testing program. The polymer is being evaluated in the form of molding compound, extrusion compound, film, varnish, and coatings.

It is expected that favorable results from some or all of these evaluations, coupled with current process studies, will provide GE with the information it needs to make a decision on supplying the market with commercial quantities.

Until the present evaluations have been completed and pilot plant production established, samples will not be available for general distribution.

The excellent electrical characteristics, high thermal stability, low water absorption, and high tensile strength of LEXAN film make it suitable for use as an electrical insulating material.



CHEMICAL reaction of GE's new LEXAN polycarbonate resin is studied by H. E. Munro, chemist. *GE Photo*

Summer Courses Offered by Many Schools

Univ. of Michigan. Intensive courses for men in engineering, science, and business are being offered starting June 17. Rapid changes in many fields have been the reason for the courses offered in automatic control, courses I and II; an engineering approach to production machining; nuclear reactors and radiations in industry; introduction to digital computer engineering; advanced digital computer engineering and logical design; introduction to digital computer and its applications; applications of advanced numerical analysis to digital computer problems; applications of logic to advanced digital computer programming; and management sciences. Registration information and general inquiry should be addressed to Co-ordinator of Engineering Summer Conferences, 2038 East Engineering Building, Ann Arbor, Mich.

Colgate Univ. The American Management Association is expanding its usual program of summer study sessions during July and August to include such year-round activities as management, executive action, marketing, cost reduction, packaging, as well as seminars in every AMA division. The management course for presidents will consist of one session, and the presidents' round table will meet twice.

West Virginia Univ. The 2nd Annual Appalachian Underground Corrosion Short Course will be held June 4-6 and consist of a complete basic course in fundamentals, a complete intermediate course, and a field demonstration. There will be an exhibit of corrosion control materials at the University Field House. Room and board will be available in the dormitories.

Tech. Career Council. A conference by this independent group will be held in Chicago, Ill., June 8-13. It is hoped that through panel discussions and individual counselling career advancements will be made for employees utilizing them at their maximum level of skill and responsibility. No registration fee is necessary, but those planning to attend should make reservations by writing to the director, M. W. Hinson, c/o The Technical Career Council, 19 S. LaSalle St., Chicago 3, Ill.

Pennsylvania State Univ. The 3rd annual seminar on automation will be held June 9-14, with emphasis on automation for in-line manufacturing, cost estimates, control systems, utilization of standard components, and other phases of automation. Registration data and other information is available from Chester Linsky, Department of Industrial Engineering, The Pennsylvania State University, University Park, Pa.

New York Univ. A series of 25 lectures to be held between June 10-14 will cover all phases of vacuum metallurgy, pumping systems, thermodynamics, specific processes, designs and operation of arc and induction melting systems, etc. Cosponsors of the program are the department of metallurgical engineering and the office of special services to business and industry.

Columbia Univ. The Graduate School of Business will hold two sessions at Arden House of "The Executive Program in Business Administration" June 16-July 27. This six-week concentrated course for top management personnel is designed to strengthen each participating executive's concepts of planning, decision making, administration, etc., and to augment his understanding of economic forces, both national and international, that affect business. The second session will be from mid-August through September. Additional information is available from H. S. Simpson, Director of Executive Programs, Columbia University Graduate School of Business, 116th Street and Broadway, New York 27, N. Y.

Industrial Management Center. Cost reduction opportunities made possible through material handling improvement will be the conference training schedule June 16-29 for the engineers and executives who attend the 4th annual material handling training conference at the Lake Placid Club in Lake Placid, N. Y. Elimination of handling bottlenecks, and better use of storage space, will be stressed. For further information, write J. R. Bright, Industrial Management Center, 56 Robbins Rd., Lexington 73, Mass.

Human Engineering Inst. Dunlap and Associates, Inc., will again conduct this annual institute for the 5th consecutive year. The five-day program, June 17-21, will consist of a planned sequence of lectures and small group discussions to acquaint design and development personnel from industry and military organizations with the newest data and techniques on Human Engineering. Enrollment will be limited in order to devote appropriate amounts of attention to the specific needs and interests of individual participants. Additional information is available from H. E. Blank, Jr., Director, 1957 Human Engineering Institute, Dunlap and Associates, Inc., 429 Atlantic St., Stamford, Conn.

Gaillard Seminar. Industrial standardization will be the topic of Dr. John Gaillard's five-day seminar June 24-28 which is to be held at the Engineering Societies Building 29 W. 33rd St., New York, N. Y. There will be 10 conferences, one in the morning and one in the afternoon each day. The seminar primarily is intended to assist management in the organization of standardization work, and to train staff personnel in the art of writing specifications. For further information and registration, write to Dr. John Gaillard, Box 273, Rt. 1, Briarcliff Manor, N. Y. Reservations may be made in advance

Massachusetts Institute of Technology. Special professional programs of one- and two-week duration ranging from missile aerodynamics to psychology of man—machine systems will be offered starting June 11 and will continue through the week of September 9. Those in industry and Government will find the intensive sessions an aid in refreshing and enlarging their knowledge with current advances in the varied fields. Further information about the summer activities is available from the Summer Session Office, Room 7-103, Massachusetts Institute of Technology, Cambridge 39, Mass.

Test Tunnel for Ship and Plane Surface Roughness

Results of basic research by a University of Maryland scientist are expected to enable designers to predict the speeds of airplanes

Future Meetings of Other Societies

American Radio Relay League, June 1-2, Oklahoma State University, Tahlequah, Okla.

ASRE, Annual Meeting, June 2-5, Hotel Fontainebleu, Miami Beach, Fla.

SAE, Summer Meeting, June 2-7, Chalfonte-Haddon Hall Hotel, Atlantic City, N. J.

American Management Association
General Management Conference, June 3-5, Statler Hotel, New York, N. Y.
Manufacturing Conference, June 10-12, Carter Hotel, Cleveland, Ohio

EEI, 25th Annual Convention, June 3-5, Palmer House, Chicago, Ill.

Chemical Institute of Canada, 40th Annual Conference, June 3-5, University of British Columbia, Vancouver, B. C., Canada

ASCE, Semiannual Convention, June 3-7, Buffalo, N. Y.

NSPE, Annual Meeting, June 5-8, Statler-Hilton Hotel, Dallas, Texas

EJC, World Power Conference, June 5-10, Belgrade, Yugoslavia

Institute of Radio Engineers
Professional Group on Production Techniques, Symposum on Production Techniques, June 6-7, Hotel Willard, Washington, D. C.
Professional Group on Military Electronics, 1st National Meeting, June 17-19, Sheraton Park Hotel, Washington, D. C.

3rd Conference on Nuclear Structure, June 6-8, University of Pittsburgh, Pittsburgh, Pa.

AIChE, June 9-12, Olympic Hotel, Seattle, Wash.

Automation, 4th Congress and 3rd Exposition, June 9-13, New York Coliseum, New York, N. Y.

American Society of Mechanical Engineers
Semiannual Meeting, June 9-13, San Francisco, Calif.
Applied Mechanics Conference, June 14-16, University of California, Berkeley, Calif.

RETMA, Symposium on Applied Reliability, June 10-11, Hotel Syracuse, Syracuse, N. Y.

American Rocket Society, Semiannual Meeting, June 10-13, Hotel St. Francis, San Francisco, Calif.

Digital Differential Analyzer Council Meeting, June 11, Ivy Suite, Statler Hotel, New York, N. Y.

3rd Western Plant Maintenance and Engineering Show, June 11-13, Civic Auditorium, San Francisco, Calif.

SPE, Plastics for Electronics Conference, June 14, Lowell Institute of Technology, Lowell, Mass.

ASTM, June 16-21, Chalfonte-Haddon Hall Hotel, Atlantic City, N. J.

Creative Engineering Seminar, June 16-21, Pennsylvania State University Campus, University Park, Pa.

Institute of Aeronautical Sciences, Annual Summer Meeting, June 17-20, Los Angeles, Calif.

ASEE, Annual Meeting, June 17-21, Cornell University, Ithaca, N. Y.

Business Efficiency Exhibition, June 17-27, London, England

Society of Nuclear Medicine, 4th Annual Meeting, June 20-23, Shirvin Hotel, Oklahoma City, Okla.

ASHACE, Semiannual Meeting, June 24-26, Manoir Richelieu, Murray Bay, Que., Canada

The British Institution of Radio Engineers, Electronics in Automation Convention, June 27-July 1, University of Cambridge, Cambridge, England

and ships before the designs leave the drafting board.

Dr. F. R. Hama, assistant research professor, institute for fluid dynamics and applied mathematics, has completed a new wind tunnel for the study of surface roughness on the sides of airplanes or ships as it affects friction resistance of water or air.

According to Dr. Hama, the sides of airplanes or ships are both smooth and rough. Rough areas are caused by paint, welding, or other protrusions.

"In our wind tunnel, we will be able to compare the velocity of air or water near a smooth surface to velocity near a rough surface," Dr. Hama, test tunnel designer, explained. "Through this measurement, it will be possible to determine the effect of surface roughness on friction resistance. This will then provide a correct prediction of the speed of a moving object," he concluded.

The test section of the wind tunnel is approximately 50 feet long, 5 feet wide, and 4 inches high. Air, generated by a 50-hp motor, will be forced through the tunnel at a speed of more than 100 feet per second.

Surface roughness of the type found on the sides of airplanes and ships will be simulated on the sides of the laboratory wind tunnel when further experiments are begun.

Arcs Go Round and Round in Lightning Arresters

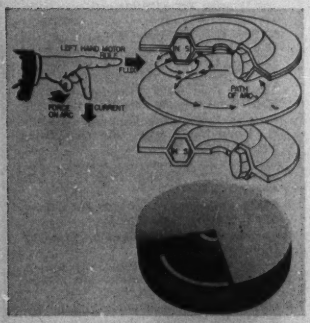
A small doughnut-shaped ceramic magnet is making life miserable for arcs in lightning arresters. The magnet placed mechanically "in series" with the gap surface provides a constant magnetic field in the gap. When the arc is drawn, it is at right angles to the magnetic field and, therefore, spins like the armature winding of an electric motor.

Previously, the arc tended to stay in one spot. With discharges of relatively long duration, such as switching surges, there could be pitting at those spots on the electrode surfaces. This eventually could change the arrester spark over.

When the arc spins and moves, pitting cannot occur, so gap life is lengthened. Also, the ability of the gap to interrupt power-follow current is improved.

Because the arc must spin, critical electrode spacing has been simplified by placing a small pimple on one surface; only this pimple spacing is critical. Once the arc is drawn, the magnetic field drags it off the pimple, and around the gap, which aids arc interruption.

The ceramic magnet is made of barium ferrite, which electrically is an insulator. However, its magnetic life is virtually infinite. The magnet is enclosed in a brass shield so that the discharge currents go around the outside of the magnet and, therefore, do not demagnetize it. Currents of 100,000 amperes have been measured in the gaps with no ill effects to the magnets.



CUTAWAY VIEW (lower right) of the new Mobilarc (registered trade mark) gap for lightning arresters. Also shown is a diagram (top) demonstrating how the Mobilarc gap ceramic magnet causes the arc to spin.

Guided Missiles and Radar More Reliable after Super Sleuthing

Guided missiles, radars, and other defense weapons will be more reliable in action, thanks to a super-sleuth with X-ray vision now used by Raytheon Manufacturing Company to check special electron tubes going into these devices.

The sleuth, a specially designed automatic X-ray detector, photographs up to 18,000 special subminiature tubes per day and ferrets out flaws hidden to the human eye, which some day may cause that tube and the weapon using it to fail.

Raytheon News Photo

X-RAY SLEUTH makes sure special electron tubes will be reliable in guided missile, radar, and other defense weapons action. An automatic X-ray detector (center) photographs up to 18,000 tubes daily and ferrets out flaws. The revolving circular table automatically feeds each tray holding more than 100 tubes to its inspection position.

Recently placed into operation by Raytheon at its Newton, Mass., tube plant, the X-ray apparatus probes each midget tube from three different angles, revealing its innermost structural secrets. The X-rays peer through the tube's 30 or more delicate parts cramped into a space only one inch long and a quarter-inch round. Some parts are four times finer than a strand of human hair.

Also scrutinized for possible defects are some 15 or 20 welds connecting the parts, the glass seal, the spacing between parts, loose metallic particles, and the glass casing. X-raying is the only way to tell whether a true weld has been made without pulling the weld apart.

The automatic apparatus, it is believed, will permit a tube manufacturer, for the first time, to X-ray tubes in mass production quantities. The new unit has 60 times greater capacity than the experimental device used in the past to test tubes in limited lots for military use.

Study of the X-rayed tubes, Raytheon engineers state, may help provide a better understanding of the effect of cosmic rays on tubes carried aloft in the atmosphere by guided missiles.

Cleveland Electric Initiates Polio Emergency Service

Designed to erase any fears of possible power failure in homes of polio patients, a special emergency service has been announced by The Cleveland Electric Illuminating Company, 75 Public Square Cleveland, Ohio.

Established on a system-wide basis, the procedure provides a 24-hour alert. It is directed from the company's Cleveland and Ashtabula communications centers to help protect polio patients throughout northeast Ohio.

Under the plan, homes of polio patients on a special list will get immediate assistance should wind, rain, snow, or any other factor cause a power interruption or failure. If trouble develops, the men in the company's trouble section are alerted at once should the home of a polio patient be affected. The family of the patient is notified by the company that needed repairs are under way.

When necessary, one of several portable generators strategically located throughout the company's four-county service area is dispatched to the scene. Line crews give first priority to restoration work in the patient's home area.

Numerical Control of Jig Borers, Hole Grinders, and Rotary Tables

The development and perfection of a wholly new system of numerical control as applied to its line of jig borers, vertical hole grinders, and rotary tables was announced recently by Pratt & Whitney Company, Inc. (P&W), a subsidiary of the Penn-Texas Corporation. At the same time, the company announced the delivery of the first of these units to the Aircraft Engine Division, Ford Motor Company in Chicago, Illinois.

This system of numerical control is believed to be the nearest approach yet devised toward complete automation of machine tools of this type. It makes possible automatic accurate positioning within 0.0001 inch and is heralded as one of the most important new developments in the machine tool industry. Vital machine tools that formerly could be used only as toolroom equipment can now be made available for efficient volume production purposes.

Under P&W's numerical control system,

P&W News Photo

DIGITAL INFORMATION punched into tape (foreground) automatically operates P&W vertical precision hole grinder (background) from operator's control panel (left).

all blueprint data needed for locating, indexing, boring, and grinding is stored on punched tape and translated directly into mechanical action by the machine. The system actually feeds blueprint information directly to the machine.

Since "Numerical Control" offers automatic programming, the high precision of jig borers, precision hole grinders, and rotary tables is made available for production work. Punched tapes are easily and economically prepared, and take the place of costly and complex fixturing. Thus, automatic programming and operation become practical for short production runs and for the machining of one or two pieces with multiple holes at a minimum of operator fatigue.

The system is based on the common decimal system (decimal of an inch and decimal of a degree of arc), and the dimensions shown on a blueprint are punched on tape as easily as numbers are tabulated on an adding machine. This decimal system eliminates the necessity of making complex mathematical "translations" which are required by automatic control systems based on binary numbers.

In the case of the numerical control system, P&W engineers established that punched records were preferable to magnetic or optical storage of digital data because of the simpler equipment necessary to sense a punched hole.

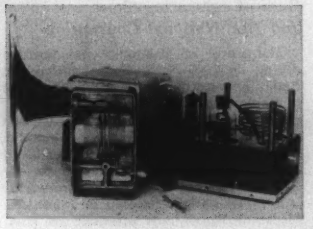
Electrical into Sound Energy without Diaphragm

A new means of transforming electrical energy into sound energy without the use of a diaphragm has been developed by engineers of the Dukane Corp., St. Charles, Ill.

This development, called the Ionovac, consists of a small open-ended quartz cell about the size of a peanut shell. One of the chambers of this cell narrows down to an aperture about the size of an automatic pencil lead. Within this small space air molecules are bombarded with a high-frequency, high-voltage current which ionizes the air.

A 20-mc oscillator supplies this ionizing energy to the air by the medium of a thin metallic unit. As this oscillator voltage varies from positive to negative peaks, the molecules of air within the chamber are correspondingly pushed in and out, creating the pressure and rarified areas necessary for the creation of sound.

When the system is used with a record player, the 20-mc oscillator current is modulated with the output of the audio amplifier and these variations are imparted to the ionized air giving rise to the equivalent of the pumping action of the usual loudspeaker diaphragm. The oscillator coils and tube are shown on right of the chassis with the cover removed; the coupling coils for the modulated r-f voltage are shown in the separate case under the compartment with



THE OSCILLATOR with cover removed is on the right of the Ionovac chassis. Coupling coils are shown in the middle of the reproducer unit in the upper compartment of which is the quartz cell in the throat of the rectangular horn.

the quartz cell. The center of this is in line with the throat of the rectangular horn, which has a cutoff at 3 kc. This is a 17-watt unit.

The frequency response of the system is essentially flat from about 1,800 cycles up to 20 kc, at 0.64 volt across 16 ohms.

It is stated by the Dukane engineers that there is no interference with television reception, because of the efficient oscillator shielding and the coaxial cable employed. Lower cutoff frequencies can be obtained by lengthening and enlarging the horn. It is also planned to manufacture units up to 100 watts or even higher. The distortion of the unit shown is about 2%.

Inasmuch as the Ionovac system can be extended up in the ultrasonic frequencies, its use may be greater in medical, research, and industrial circles than in the entertainment field.

Electronic Test of Distributors on Assembly Line

An ignition distributor development program has been climaxed by sponsoring the development of a new high in ignition distributor quality control—the first all-electronic distributor test stand. Installation of a battery of this new equipment in the Ford Parts and Equipment Division plant in Ypsilanti, Mich., provides the Ford Motor Company with distributor uniformity heretofore unknown in the motor vehicle industry.

These units, developed and manufactured by Airborne Instruments Laboratory (AIL), Mineola, N.Y., to Ford Motor specifications, functionally check each distributor produced by the Ypsilanti plant, displaying the parameters of performance in pictorial form on a 17-inch television picture tube for calibration by operating and quality control personnel.

The AIL distributor test stand is used for the production-line testing of a fully assembled distributor. The equipment displays the following operational characteristics of a distributor: (1) dwell and dwell uniformity, (2) advance-angle-versus-speed, (3) firing uniformity, and (4) advance-angle-versus-vacuum. All information is displayed to the operator on the face of a 17-inch television-type cathode-ray tube having a long-persistence phosphor. The display size is 10 inches in the vertical direction and 15 inches in the horizontal direction. The over-all accuracy of the equipment is within $\pm 1\%$ of full scale on either axis. Provision has been made for a tolerance mask to be placed over the cathode-ray tube.

A calibrated angle pulser is supplied on the drive shaft of the equipment for checking the nominal maximum advance point and the nominal dwell point on the display mask, and circuits are provided for a convenient calibration check by the operator.

The over-all power requirement for the equipment is about 4 kva at 440 volts, 60

SUBJECTING each distributor to a more severe range of conditions than it would normally encounter in the automobile engine, the analyzing equipment ensures optimum durability and performance.

cps, three phase. The over-all physical size of the equipment is 40 inches wide, 50 inches deep, and 7 feet high. The height of the working table level is 36 inches. The weight of the machine is about 2,000 pounds. Joint Industry Conference Standards are followed throughout.

AIME Annual Meeting Highlights

J. K. Richardson, assistant general manager, Chino Mines Division, Kennecott Copper Corporation, Hurley, N. Mex., addressed the annual Extractive Metallurgy Division luncheon of the American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME), during their annual meeting. The luncheon was held at the Jung Hotel,

New Orleans, La. Mr. Richardson spoke on the subject "New Horizons—New Responsibilities."

New developments in industry and their bearing on social responsibilities were discussed by Mr. Richardson. As automation becomes more prevalent, it was stated, we create additional problems of labor. Mr. Richardson also developed the relationship of industries to communities as industrial changes come about.

During the five-day annual meeting many subjects relating to the technology and economics of mining, metallurgy, and petroleum were covered.

The Office of Naval Research was cited by AIME at a dinner meeting of its Metals Branch, held in New Orleans, for its "effective and continuing support of fundamental research in metallurgy and the physics of metals." This is the 10th Anniversary of the establishment of Office of Naval Research.

The citation reads in part, ". . . instrumental in the training of over three hundred and fifty graduate students and the prosecution of research projects that resulted in over seven hundred and fifty technical papers, the Office of Naval Research program in metallurgy has made a significant contribution to the metallurgical profession. This program of research has demonstrated that there can be a continuing, effective partnership between the Government, the universities, and other research groups in the pursuit of significant basic investigations. The publications stemming from this work have reflected credit in the investigators and the Office of Naval Research."

The citation was presented to Captain A. B. Metsger, USN, who received it on behalf of Rear Admiral Rawson Bennett, Chief of Naval Research. The citation was presented by Dr. Robert Mehl, head of the department of metallurgical engineers, Carnegie Institute of Technology.

Following action taken at the annual meeting held in New Orleans, La., the American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME) now conducts its activities through a reorganized structure.

Previously known as the Mining, Metallurgical and Petrolem Branches of AIME, these units now are the Society of Mining Engineers of AIME, the Metallurgical Society of AIME and the Society of Petroleum Engineers of AIME. Though each has its own officers and administrative setup, the three constituent societies remain under control of the AIME Board of Directors.

The national president of AIME is G. J. Holt, of Ishpeming, Mich., general manager of the Cleveland-Cliffs Iron Co. The secretary is E. O. Kirkendall. Headquarters of AIME and the Mining and Metallurgical societies are in New York, N. Y. The Petroleum headquarters continues in Dallas, Texas.

E. A. Jones, first president of the Society of Mining Engineers of AIME, is manager of the Southeast Missouri Division, St. Joseph Lead Co., in Bonne Terre, Mo.

The president of the Metallurgical Society of AIME is J. C. Kinnear, Jr., of McGill, Nev., general manager, Nevada Mines Division, Kennecott Copper Corp.

The first president of the Society of Petroleum Engineers of AIME is J. P. Hammond, assistant general superintendent of Amerada Petroleum Co., Tulsa, Okla.

The new AIME bylaws provide that the Metallurgical Society of AIME shall consist of the Institute of Metals Division, Iron and Steel Division, and Extractive Metallurgy Division. The Society of Mining Engineers of AIME shall consist of the Coal Division, Industrial Minerals Division, Minerals Beneficiation Division, and Mining, Geology and Geophysics Division. The Society of Petroleum Engineers of AIME is not set up in divisions.

Each of the three Societies, in rotation, will name the AIME national president for one year. Each year, each of the Societies will elect two AIME national directors for three years and will designate two of its seven institute directors as AIME national vice-presidents for one year.

Radio Engineering Show and IRE National Convention

The world of electronics was revealed during the 1957 National Convention and Radio Engineering Show of the Institute of Radio Engineers (IRE).

New York, N. Y., was host to the engineers and scientists who came to the four-day meeting at the Waldorf Astoria Hotel and the New York Coliseum from all over the United States and many foreign countries.

The IRE's highest technical award, the Medal of Honor, was presented to J. A. Stratton, chancellor of Massachusetts Institute of Technology (MIT), for outstanding contributions to the development of radio engineering as a teacher, physicist, engineer, author, and administrator.

The Founders Award, given on special occasions only, was given to R. A. Heising former Bell Telephone Laboratories engineer, for his work in helping to establish IRE headquarters, and other contributions. O. G. Villard, Jr., Stanford University, received the Morris Liebmann Memorial Prize, for work in connection with meteor astronomy and ionosphere physics.

The Browder J. Thompson Memorial Prize went to D. A. Buck, MIT, for his paper on "The Cryotron," a superconductive computer component. The Harry Diamond Memorial Award went to George Goubau, Signal Corps, Signal Corps Engineering Laboratories, for his researches in ionospheric physics and discovery of surface-wave transmission.

The Vladimir K. Zworykin Television Prize was given to Donald Richman, Hazeltine Corp., for discoveries in color television. The W. R. G. Baker Award was made to three persons for work in the field of transistors—R. J. Kircher of Hughes Aircraft Co., and R. L. Trent and D. R. Fewer of Bell Telephone Laboratories.

A problem "as broad as life itself"—the management of people—received special emphasis as psychological aspects of engineering in industry were discussed by experts in personnel management and psychology who told the electronics engineers that "engineers are prone to be think-centered rather than people-centered, even when they take over management functions."

A new experimental electronic system that enables polio victims to use respiratory muscles that are still intact to control breathing of the iron lung was described by Dr. L. H. Montgomery, Vanderbilt University School of Medicine.

An "inductive inference machine" that can learn how to solve arithmetic problems based on a few correct examples was described by R. J. Solomonoff, Technical Research Group, New York.

A magnetic tape recording system for teaching electrocardiography was described by G. N. Webb and Dr. W. R. Milnor, Johns Hopkins Univ. School of Medicine.

Details of an electronic light amplifier panel that can increase by 1,000 times the visible brightness of a projected light image and convert X rays to bright visible light were given by Benjamin Kazen, RCA Laboratories, Radio Corporation of America (RCA).

Another novel display device, an electrostatic character-writing tube, was described by Kurt Schlesinger, B. Maggos, and A. F. Hogg, Motorola, Inc.

Methods for using high mountains between a radio or television transmitter and receiver to improve, rather than hinder, the reception of UHF signals were described by R. E. Lacy of the Signal Corps Engineering Laboratories, Fort Monmouth, N.J.

Other reports given at eight sessions dealt with the role of electronics in improving both aircraft and pilot performance.

The problem of sending coded messages as speedily as possible and yet with the least chance of error was discussed in a session on Information Theory by W. B. Bishop and B. L. Buchanan of the Air Force Cambridge Research Center.

Engineers at the U. S. Air Forces' Rome Air Development Center (RADC), Rome, N. Y., discussed a practical source of electrical energy that uses heat from decay of radioactive isotopes to drive a semiconductor "thermopile"—a transistor-like device which produces electrical energy when heated.

In a paper on "biconjugate networks," H. T. Budenbom showed how these structures can be used in electronic "brains" to attain far higher speeds than present-day computer circuits.

Computer experts from International Business Machines (IBM) and Remington Rand Univac discussed the use of computers for designing ultrareliable circuits based on lift-test data.

Under pressure of the military's guided missile program, the electronics industry has intensified a study of equipment reliability which eventually may result in televisions and radios that will function "indefinitely" without failure.

The Air Force has developed a program, described by J. J. Naresky, RADC, which expresses reliability of equipment in terms of actual numbers. Each component in the particular equipment has its own "probability of failure" number.

The electronic mail sorting system, described by M. M. Levy and A. Barszezewski, has been under development by the Canadian Post Office Department in Ottawa (*Electrical Engineering*, December 1956, p. 1144).

During sessions at the Waldorf Astoria and Coliseum, 280 papers were presented, covering 24 main branches of the art, ranging from radio astronomy and medical electronics to that of color television and high fidelity.

Beacon for Small Planes Is Developed

A siren voice beckoning not toward disaster but to safety will soon be heard by pilots.

The feminine tones of the "Talking Beacon," a portable unit that can be put into operation within an hour, electronically will "steer" thousands of light planes to safe landings. Most small craft pilots never before have benefited from radio beams.

This newly developed instrument provides the pilot with the correct compass heading to the airport. The beacon's voice gives these headings for planes located at any point on the compass. This is a boon to small planes because it eliminates the need for heavy and expensive airborne instruments. All that is needed is a standard vhf receiver and a compass.

The selection of a woman's voice for the beacon involves more than allure. Feminine tones broadcast more clearly than masculine ones, a fact reflected in the increasing number of women at control tower microphones.

Developed by Air Associates under sponsorship of the Army Electronics Proving Ground, Fort Huachuca, Ariz., the beacon can be received more than 50 miles away, depending on altitude.

The U. S. Army Signal Corps has first claim on production for its world-wide logistical network. On a co-ordinated civilian basis, only about 150 units would be needed to blanket the United States, but there are many foreign countries with vast sparsely populated areas whose bush pilots will find the beacon an invaluable navigation aid.

Amazing in its very simplicity, the Air Associates "Talking Beacon" looks like a box with a revolving bed spring overhead. This box is an enclosed metal body of the type used on commercial trucks. It contains electronic equipment and supports an 18-foot mast, transmitters, and antennas.

As the antennas revolve, a voice gives the direction of the beam at 15-second intervals or every 20 degrees. A pilot flying between two beams will pick up both and can judge his proximity to each within three degrees by the relative strength of their reception. When he is on one beam he will hear it loud and clear. The two at his flanks will come in very weakly.

By tuning in on two stations, he can use simple mathematics to find his exact position as well as distance from the nearest airport.

The beacon's truck body construction makes it easily transportable. The antennas disassemble in order to be stowed inside while the unit is being moved. Total weight is less than two tons. On location, the beacon can be set up quickly without a land survey or complicated procedure.

Center for Electronic Calibration

Construction has begun on an Electronic Calibration Center to be established at the Boulder (Colo.) Laboratories of the National Bureau of Standards (NBS). Scheduled for completion in 1957, the new center will provide the NBS with greatly expanded facilities for electrical and electronic calibration services at all frequencies now in general use.

The Calibration Center is being set up in response to the armed services' urgent and continually increasing need for accurately calibrated electronic equipment to be used in radar, aircraft control, and missile guidance. About half the cost of a modern fighter plane now goes into electronic devices for navigation, fire control, and other purposes. In order for this equipment to work together as a unit, each of the separate components must be specified, constructed, and evaluated according to accurately calibrated reference standards.

For example, in air-to-air refueling of U.S. Air Force planes, radar navigation equipment is used to rendezvous the tanker with the aircraft to be refueled. To assure contact between the two aircraft, their navigation equipments must be precisely calibrated in terms of a single frequency standard. This requires a total of 29 test instruments, each accurate to 1%. To calibrate the test instruments to this accuracy, 25 measurement standards, accurate to 0.01%, must be used. Such uniformity requires inspection and calibration of all secondary standards by a single agency in terms of a master set of standards.

Initially, the center will perform calibrations at particular fixed frequencies already in wide use ranging up to 40,000 mc. However, its eventual aim will be to measure and standardize all usable electrical and radio quantities from direct current, or zero frequency, to at least 100,000 mc. Work in the range from direct current up to 30 kc will be shared with the NBS Washington Laboratories. At first, the Federal Government is expected to be the largest user of the calibration service, but the Center's facilities will also be available to industry, universities, and scientific organizations.

The quantity of these calibrations required today is so great that branching chains of measurement are necessary to extend the primary standards to the shop or field instruments, the end goal of the calibration process. The large number of links in each chain, through which the units of measurement must be transferred, requires the highest practicable accuracy at each step in order to assure adequate accuracy of the shop and field instruments. The new Calibration Center should provide an effective means of transmitting accurately the nation's basic electrical standards at all frequencies to a wide variety of users.

The Calibration Center will maintain reference standards derived from the absolute ohm and volt. Those standards most urgently needed for the initial period of operation are now under construction. However, new standards will undoubtedly be required in the future to replace reference standards made obsolete by technological advances.

The Center will have a staff of about 50, headed by H. W. Lance. It will function as part of NBS Radio Standards Laboratory, which has been charged with the responsibility for basic research and development leading to improved radio standards, measurements techniques, etc., for all r-f and microwave electrical quantities. The Laboratory also is responsible for primary radio standards.

NEW BOOKS

The following new books are among those recently received at the Engineering Societies Library. Unless otherwise specified, books listed have been presented by the publishers. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books in question.

ANALOG COMPUTERS: THEIR INDUSTRIAL APPLICATIONS. Proceedings of a Symposium, April 1956, Sponsored and Published by Midwest Research Institute, 425 Volker Blvd., Kansas City 10, Mo. 210 pages, 8½ by 11 inches, paper. $5. Eleven papers and a round-table discussion devoted to the use of computers for design and operation of engineering systems, flood routing and other hydraulic problems, economic programming, industrial control problems, and other technical and nontechnical problems.

ANALYSIS FOR PRODUCTION MANAGEMENT. By E. H. Bowman, R. B. Fetter. Richard D. Irwin, Inc., Homewood, Ill., 1957. 503 pages, 6 by 9¼ inches, bound. $7.80. This text for university student and interested industrialist provides an analytical approach to economic problems of production management. The methods of analysis potentially useful in making economic decisions mostly involve mathematics and are organized in four major groups: orientation, mathematical programming, statistical analysis, and economic analysis. The authors, both assistant professors of the School of Industrial Management at the Massachusetts Institute of Technology, use many cases drawn from real situations as illustrations.

APPLIED ANALYSIS. By Cornelius Lanczos. Prentice-Hall, Inc., Englewood Cliffs, N. J., 1956. 539 pages, 5½ by 8¾ inches, bound. $9. The purpose of this book is to cover the area between "pure" and strictly "applied" mathematics by presenting the analysis and design of finite processes which rapidly approximate solution of an analytical problem. This handling of major mathematical tools to minimize error in a relatively small number of steps is of primary interest to the engineer and physicist who can use them.

COMPANY INVESTIGATIONS OF AUTOMATIC DATA PROCESSING. By P. B. Laubach. Division of Research, Harvard Business School, Soldiers Field, Boston 63, Mass., 1957. 258 pages, 5¼ by 8¼ inches, paper. $5. Intended as an aid to management personnel interested in the use of computers for business data, this book describes briefly computer components and programming, presents case histories of company evaluations of data processing methods, and considers in detail the steps to be taken in investigating the practicability of a data processing system. Chapters on cost and savings estimates and on the selection of equipment are included.

ELEKTRISCHE UND MAGNETISCHE POTENTIALFELDER. By Herbert Buchholz. Springer-Verlag, Berlin, Germany, 1957. 552 pages, 6¼ by 9¼ inches, bound. DM 72. A thorough mathematical treatment of electrical and magnetic potential fields, which deals with the two types of boundary value problems arising in electrostatics, magnetostatics, and the electric current. The fundamental physical laws are stated; the mathematical approach and operations are developed and emphasized throughout, especially the Laplace equation; and both plane and 3-dimensional electrical and magnetic fields are discussed including high-frequency.

GRAPHICS FOR ENGINEERS. By W. J. Luzadder. Prentice-Hall, Inc., Englewood Cliffs, N. J., 1957. 597 pages, 6 by 9¼ inches, bound. $8.65. A book on engineering drawing which covers fundamentals, but in which emphasis is on engineering geometry, multiview representation, basic descriptive geometry, and freehand sketching. Particular attention is given to perspective pictorials and graphical methods for solving engineering problems. The purpose is to develop the ability to visualize spatial conditions and to use graphical forms of representation as a means of communication. There is a special chapter on graphs, charts, and nomograms.

LEXIQUE TECHNIQUE. (François-Anglais, Anglais-Français) By Guy Malgorn. Gauthier

villars, Paris, France, 1956. 2 volumes, 5¼ by 8¼ inches, paper. $7.06 each volume. This standard English-French technical dictionary, now in its fourth edition, has now a companion French-English volume. It covers the entire field of technology: construction work of all kinds, machines and machine-shop practice, electrical engineering and electronics, shipbuilding, mining, metallurgy, petroleum, transportation, etc. Different meanings are given for various contexts, and numerous examples of phrases and combinations are given for many words. General words are not included except in specific applications.

PROGRESS IN NUCLEAR ENERGY. Series 8. The Economics of Nuclear Power Including Administration and Law. Edited by J. Guéron and others. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y., 1957. 513 pages, 6 by 9¼ inches, bound. $17. This volume is the beginning of the formulation of a series of techniques for the economic evaluation of atomic power. There are five sections: a summary of the heat and electricity resources of various countries and their predicted needs for the next 50 years, which are likely to require unusual energy sources; general nuclear power economics; nuclear fuel cycles and their possibilities; reactor programs and reactor economic data; legal and administrative problems involved in the industrial utilization of atomic energy. Much of the information is from the Geneva conference.

RECORDS AND RESEARCH IN ENGINEERING AND INDUSTRIAL SCIENCE. By J. E. Holmstrom. Chapman & Hall Ltd., London, England, third edition, 1956. 491 pages, 5½ by 8¼ inches, bound. 60s. The author's stated theme is that purposefully directed experimental research and efficiently exploited records are interdependent necessities for progress. The first part of the book describes methods of research, giving notes on relevant literature, and discussing the organization, research activities, and publications of national and international scientific institutions and societies. The remainder of the book, about a quarter of the contents, describes types of records (reports, articles, documents, and books); bibliographical aids; and methods for acquiring, storing, and searching records. Thirty pages of bibliography are appended.

DIE SELBSTTATIGE REGELUNG. By A. Leonhard. Springer-Verlag, Berlin, Germany, second edition, 1957. 376 pages, 6¼ by 9¼ inches, bound. DM 39. This text discusses the basic theoretical principles of automatic control as well as practical examples of its use. Following a chapter on fundamentals, analytical and graphical methods for the determination of suitable control processes are considered in detail. The stability of control is then examined. The final section is devoted to methods for the determination of appropriate control constants.

THEORIE UND TECHNIK DER PULSMODULATION. By E. Hölzler and H. Holzwarth. Springer-Verlag, Berlin, Germany, 1957. 505 pages, 6¼ by 9¼ inches, bound. DM 57. Theory and practice of pulse modulation are covered in detail beginning with a review of the various separate methods and combinations. Basic circuits and other fundamental engineering aspects are explained. Over 100 pages are devoted to transmission distortion, influence of "noise," and construction of communication systems utilizing pulse modulation. Topics covered include analysis of time functions, quantized signals, coding, and generators of various types of oscillations.

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THE RADIO AMATEUR'S HANDBOOK. Published by the American Radio Relay League, Inc., West Hartford 7, Conn., 34th edition, 1957. 136 pages, 6½ by 9½ inches, paper. $3.50. This edition incorporates the latest in accepted practice and includes basic theory sections, radio construction information and a catalog section in which specifications and measurements of communication equipment are given. New equipment in all categories is included throughout the book. There are chapters on vacuum-tube principles, semiconductor devices, receivers, and transmitters. Beam antennas and high-power amplifiers are new additions to the vhf section. An index to the vacuum tube and semiconductors data section lists the tubes in alphabetical and numerical order for easy reference.

TECHNICAL LITERATURE

The following recently issued technical literature may be of interest to readers of *Electrical Engineering*. All inquiries should be addressed to the issuers.

FARM ELECTRIFICATION RESEARCH. A report on special studies and research contributed to or conducted by electric operating companies from January 1951 through December 1955 has been published by Edison Electric Institute. The 60-page report, compiled by the Institute's Farm Group, summarizes 222 separate research projects or special studies supported or sponsored by electric companies, covering 87 different categories. Work is being carried on to determine the effectiveness of electric applications in such fields as barn cleaners, calf pen heating, egg collection and cooling, fruit processing, greenhouse heating and ventilation, irrigation, pest control, plant propagation, poultry disposal, livestock feeders, crop processing, automatic smokehouse, tobacco curing, and wiring. Reports from 29 states and Canada are included in the publication. There were 28 land grant colleges or universities participating in the studies. A number of projects included in the report are supported by the U. S. Department of Agriculture. The new report contains research activities information not covered in similar reports published in December 1949, and 1950. Available at $1.25 per copy from Edison Electric Institute, 420 Lexington Ave., New York 17, N. Y., quantity prices will be furnished on request.

BALLAST SOUND RATING CALCULATOR —*GEN-147*. A new sound rating calculator for ballasts to aid specifiers of fluorescent lighting installations in determining beforehand whether or not they will encounter a noise problem, has been announced by the General Electric Company's (GE) ballast department. The average sound level of all GE ballasts currently listed has been measured. This sound rating measurement is stamped on each case. By knowing this rating (number of ballasts in installation, size and accoustical characteristics of room, and room's ambient sound level), specifiers can determine whether or not a sound problem exists. According to GE engineers, the calculator indicates whether the noise problem will be annoying, audible, slightly audible, or inaudible for the particular application. The specifier is then able to select ballasts with proper sound rating. The sound rating calculator can be obtained by sending $1 with name and address to: General Electric Company, Section 1662, Schenectady 5, N. Y.

CENTRALAB CONTROL GUIDE. Centralab, Division of Globe Union Inc., announces availability of its Pocket Control Guide No. 5. This handy control cross-reference guide is published semiannually to make the latest and most up-to-date replacement control information available to everyone. Hundreds of new listings are in the 106 pages which fit neatly into pocket or repair kit. Priced at 20¢, it will be available at all Centralab distributors or by writing direct to Centralab, Division of Globe Union Inc., 900 E. Keefe Ave., Milwaukee 1, Wis.

COLOR IN PROFESSIONAL MOTION PICTURES. Published by the Society of Motion Pictures and Television Engineers (SMPTE), 55 West 42nd St., New York 36, N. Y. The 104-page book (27 color pages) represents more than a year's work by a special committee of experts working under the SMPTE's Color Committee. The 12 chapters take up such topics as: characteristics of color, color films and processes, photographing a motion picture in color, special effects, color processing and printing, and relationship of motion pictures and color television. Copies have been distributed to all SMPTE members in good standing. The book is available to the public at $3.50.

DESIGN OF ELECTRONIC EQUIPMENT FOR MAINTAINABILITY. J. D. Folley, Jr., and J. W. Altman, American Institute for Research for Wright Air Development Center. April 1956. 180 pages. $4.50. (Order *PB 121439* from Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C.) Maintenance of complex electronic equipment is a major problem of the military services, particularly in view of the shortage of highly skilled maintenance technicians. This handbook presents information intended to forestall costly, time-consuming maintenance of operating electronic systems by "building in" provisions for effective maintenance during development of the equipment. Features of design which will afford preventive and corrective maintenance of both ground and airborne electronic systems are presented.

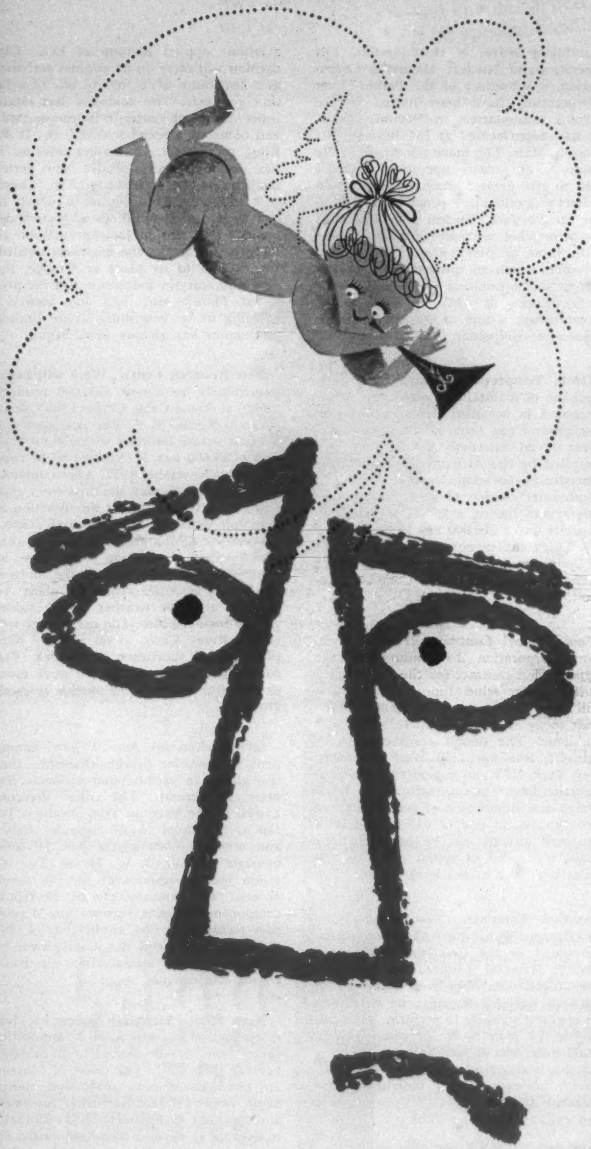
PREVENTION OF MECHANICAL VIBRATIONS IN ELECTRONIC CHASSIS—DESIGN MANUAL. W. F. Stokey, C. F. Zorowski, and F. C. Appl, Carnegie Institute of Technology for Rome Air Development Center. September 1955. 96 pages. $2.50. (Order *PB 121564* from Office of Technical Services, U.S. Department of Commerce, Washington 25, D. C.) Previous investigations had shown that mechanical damage will occur to an electronics chassis subjected to a sustained vibration of the same frequency as the natural frequency of the chassis. For maximum protection against resonant vibration, the natural frequency of the chassis must ordinarily be somewhat higher than that of the chassis-isolator assembly. By the method of frequency determination described in this manual, the designer may identify the lowest natural frequency of a chassis. The setting up and solution of the determinant for the frequency equation is discussed, along with the necessary eigenvalues.

WAVE PROPAGATION. This book by Dr. Alexander Schure (Volume 11 Electronic Technology Series) deals with the fundamental nature of electromagnetic radiation covering the various factors involved in the makeup and transmission of electromagnetic waves, with emphasis on the propagation of these waves. Describes and illustrates wave reflection and refraction, normal tropospheric propagation, and scatter propagation. Numerous diagrams to clarify all points covered with a view to practicality. Available from John F. Rider Publisher, Inc., 116 W. 14th St., New York 11, N. Y., 64 pages, $1.25.

PROCEDURE HANDBOOK OF ARC WELDING DESIGN AND PRACTICE. Revised eleventh edition of this well-known book contains a vast amount of information on all phases of arc welding. Over 1,300 pages with 1,100 illustrations, pictures, and charts; price $3.00, postpaid in U.S.A., $3.50 elsewhere. Publisher: The Lincoln Electric Company, Cleveland 17, Ohio.

RETMA STANDARDS. Three new recommended RETMA Standards have been published by the Radio-Electronics-Television Manufacturers Association (RETMA) Engineering Department, 11 W. 42nd St., New York 36, N. Y. Titles of the standards are: *RS-181*—Iron Core Charging Inductors, 60¢ (a revision of *TR-712*); *RS-182*—Class A Variable Air Capacitors, 30¢ (reaffirmation of *RE-106-A*); and *RS-183*—Output Transformers for Radio Broadcast Receivers, 25¢ (reaffirmation of *REC-124*).

DOCUMENTATION IN ACTION. Based on proceedings of the recent Western Reserve Conference bearing the same title, this book offers solutions to the hundreds of problems that arise in storing and using recorded knowledge. Edited by J. H. Shera, Allen Kent, and J. W. Perry, the book also includes the work of 13 other outstanding documentalists and librarians who have contributed instructive, up-to-date articles on every phase of the subject. Principally, the book carries out its purpose by describing the state of documentation today; evaluating and explaining the last decade's important advances; showing how machines, systems, education, co-operation, and language can be effectively used in your operations; offering conclusions of the planning group with regard to subjects for future research. Price: $10. Published by Reinhold Publishing Corporation, 430 Park Ave., New York 22, N. Y.



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When that voice prods your professional ego with, "You can do bigger and better things!," do you smother it with a wet blanket of doubt?

And when that same voice whispers to you of a gentle climate where the snow is yours just for the asking and sunshine is always yours for the basking, do you clobber it with the sledge hammer of self-denial?

Don't kill that voice! Its wisdom could lead you to a place where you'll find those bigger things, that better life—Firestone. If you've a mind that can matter in the guided missile field, Firestone needs you in its vital development program for the Army's "Corporal," first surface-to-surface guided ballistic missile. Here are just a few of our needs:

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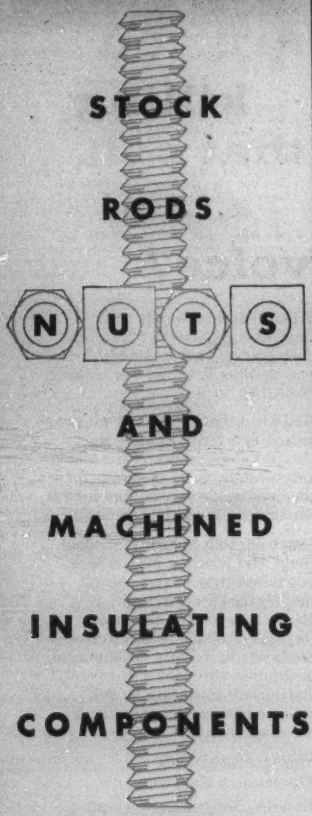

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INDUSTRIAL NOTES

Subsidiary Moves to Headquarters. The operations of Nuclear Magnetics Corporation, a subsidiary of the Perkin-Elmer Corporation, have been moved to the latter's headquarters in Norwalk, Conn. It had been located at 154 Boylston St., Boston, Mass. The move was made in the interests of greater operation efficiency and to give greater emphasis to the subsidiary's development program. By locating in Norwalk, Nuclear Magnetics will be better able to co-ordinate its activities with those of Perkin-Elmer's Instrument Division, which are quite similar. Nuclear Magnetics Corporation was established by Perkin-Elmer in 1955 to develop and manufacture a line of nuclear magnetic resonance equipment.

Mobile Temperature Control Unit. The problem of maintaining comfortable temperatures in occupied airplanes while on the ground has been solved by the creation of an extremely mobile unit now supplied by the Airtemp Division of the Chrysler Corporation, Dayton, Ohio. The conditioner consists of a compact reversible system having a 25-ton refrigerating capacity and a 200,000 Btu heating capacity. This complete equipment is carried in a Dodge truck with a specially designed body by Fruehauf Trailer Company, Detroit, Mich.

Wind Tunnel Contract. Republic Aviation Corporation has announced the signing of a contract for the design of a million-dollar wind tunnel facility that will help the company in designing aircraft to fly at speeds of up to 3,000 miles an hour. The design contract is with Burns & Roe, Inc., 160 West Broadway, New York, N. Y., an engineering and construction firm. The contract calls for detail design and supervision of construction of two tunnels, in one of which models of proposed aircraft can be tested at four times the speed of sound which is 760 miles per hour at sea level.

Low-Cost Computer. Now available to Government and industy, these computers, developed by the Computer Division of Bendix Aviation Corporation, Los Angeles, Calif., can help ease effects of the national engineer shortage by extending an engineer's ability to perform. They are within the price range of comparatively small industries as well as large ones, research laboratories, military establishments, universities, and individual Government agencies.

Aim and Name Change. The reorganization of Air Associates, Inc., Teterboro, N. J., henceforth to be known as Electronic Communications, Inc. (ECI), includes a redirection of aims, new emphasis on electronic research, as well as physical relocation of all operations. The name Air Associates, for 30 years prominent in aviation, will be retained for an aviation supplies division of ECI. This division will carry on its original activities as a distributor of its myriad line of aviation products. The company has established a research center in Baltimore, Md., and obtained a noted scientist, Dr. D. R. King, to direct it. A further advance is the projected move of all New Jersey facilities to St. Petersburg, Fla. There, ECI will have ample space in which to add to its initial buildings as growth demands. The Florida location will be an incentive to attract the engineers needed. In addition to its plant at Orange, the new laboratory in Baltimore, and the projected Florida site, ECI has leased a building in St. Petersburg where limited production has already been begun.

New Research Center. Work will begin immediately on a new $500,000 research center at Rome Cable Corporation's main plant in Rome, N. Y. The new center, a 121-foot square building with a total floor area of 25,600 feet, is expected to be completed by November 1957. Approximately 50 employees will man the three-story glass and brick structure under the direction of Rudolph Schatzel. The research center will feature a complete pilot plant so that experimental production runs can be made without interrupting the normal production activities within the plant. An outdoor area for weather testing cables will be included also. The new center will enable Rome Cable to do a more complete job of fundamental research. The company also will be able to work more closely with independent outside research groups.

Servomechanisms, Inc. A new component division for Servomechanisms, Inc., specializing in vacuum film products, has been announced. The new division, known as the Vacuum Film Products Division, is located in El Segundo, Calif., and occupies 5,500 square feet. Division manager will be D. W. Moore. The division will be responsible for the development and manufacture of electronic components utilizing vacuum film deposition techniques. The application of this technique will stress the development of high-temperature miniaturized electronic circuit components.

New Plant. Electrical Industries, formerly located in Newark, N. J., announces completion of their new plant situated in Murray Hill, N. J. The plant in Murray Hill will house new production equipment, improved manufacturing processes, and new test equipment. This will make it possible to expand customer service on both standard EI terminals and custom glass-to-metal seals. Additional construction features of the new facility include air-conditioned offices and a cafeteria. The new plant address is Electrical Industries, 691 Central Ave., Murray Hill, N. J.

(*Continued on page 24A*)

"We like the convenient storage characteristics of POC Bushings ---no special procedure or special handling is required."

"These totally-enclosed oil-filled bushings for lower voltages will surely create a trend."

"THE CADILLAC OF BUSHINGS!"

"We gave it more severe tests than any other bushing we ever tested --- and we approve it without modification or alteration."

"Excellent Design."

"AN EXCELLENT DESIGN, AND MANUFACTURED IN THE BEST OF FACILITIES."

"An ideal design, and well-suited to applications where existing bushings cannot be used."

"A superior bushing, but we'd expect nothing less from Lapp."

"Seems to be an excellent bushing; we can find no faults whatever."

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*PAPER-OIL CONDENSER TYPE
TOTALLY-ENCLOSED CORE
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In its first six months after announcement, the Lapp POC* Bushing has won the enthusiastic endorsement of utility engineers and equipment manufacturers from coast to coast. Rigorous characteristic and performance tests have been conducted in customer laboratories or in the Lapp laboratory under customer supervision. Practically every utility and every equipment manufacturer who have seen this bushing have placed it on Approved or Standards Lists—or tell us they are in process of approving it.

Lapp POC* is the bushing design of the future —ready to serve you reliably today.

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MECHANICAL
PROPERTIES
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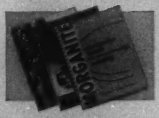
BETTER PERFORMANCE
LOWER MAINTENANCE

Motor and Generator Brushes
Morganite brushes enjoy a reputation world-wide for trouble-free service. Available for fractional horsepower, aircraft, automotive, traction and industrial applications.

Carbon Brush Holders
Assure high efficiency brush operation by maintaining positive contact between the brush and the commutator or ring. Standard types include cantilever radial, radial, trailing, reaction and AC slip ring holders.

Electrical Contacts
Including drum controllers, contactors and starters. Incorporate metals in a refractory carbon base for improved electrical conductivity and mechanical strength. Contacts are self-lubricating, non-welding.

Carbon Current Collectors
Reduce operating costs on travelling cranes. Cost less, wear longer and reduce conductor wear to a minimum. Will not blister or rough conductor, afford trouble-free service over extremely long periods.



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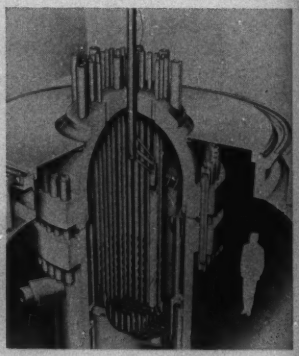
(Continued from page 18A)

Industrial Notes

Look, No Hands. The artist's drawing shows how remote handling equipment will remove long, box-shaped nuclear fuel elements for examination or replacement at the world's first full-scale atomic power plant designed exclusively to serve civilian needs. The plant is being built near Shippingport, Pa. Westinghouse Electric Corporation designed the nuclear portion of the plant for the Atomic Energy Commission. The sketch also shows how the nuclear core with the uranium fuel charge is housed inside a 250-ton, 9-inch-thick steel pressure vessel. Shrouds extending through the top of the pressure vessel will contain the control rods of



neutron absorbing material with which engineers will be able to speed up or slow down the atom-splitting or heat-producing processes. When the plant is completed this year, it will be operated and maintained by Duquesne Light Company of Pittsburgh, Pa., to supply electricity for homes and industry near Pittsburgh. Duquesne Light is building the turbine-generator portion of the plant.

Name Change. Effective immediately, the Radio Corporation of America (RCA) Tube Division will be known as the RCA Electron Tube Division. The change has been made to define more precisely the type of products manufactured and merchandised by this division.

ACF Industries, Inc. The headquarters offices of ACF Industries, Inc., for 32 years located at 30 Church St., N. Y., will be moved to 750 Third Ave.; a building is now being erected on the block front between 46th and 47th Streets. In addition to company headquarters, the new space would also house the home offices of American Car and Foundry, and Shippers' Car Line, two of ACF's product divisions. ACF will occupy four floors, 9 through 12, of the 34-story building. The move is scheduled for April 1958.

(Continued on page 36A)

Roving reporter, half mile under the sea

Exploring at the bottom of a 2000-foot coaxial cable, "Project Fisheye" now roams the ocean depths collecting information for our Navy about sunken vessels, currents, and mysterious undersea life. Its findings are televised to observers on the surface.

Such information from underseas may well prove as valuable to man as the facts radioed from our man-made satellites in outer space.

Like the electronic age itself, this submarine marvel just couldn't work without the best of electrical insulations—the kind CDF is famous for . . . insulations designed and made for outstanding performance under critical conditions.

FOR SPECIFIC INFORMATION on CDF products, see Sweet's, Electronics Buyers' Guide, and other directories. Then send us your print or your problem, and we'll return free samples and technical literature.

CDF MAKES Dilecto Laminated Plastics • Celoron and Polyester-Glass Molded Plastics • Micabond Mica Products • Diamond Vulcanized Fibre • Vulcoid • Flexible Tapes of Teflon*, Silicone, and Micabond • Resin-Impregnated Spiral Tubing • *Complete Fabrication Facilities.*

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¾ H.P.-120-240 V. A-C

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15 Amp. 125 V. A-C [L]
¾ H.P.-120-240 V. A-C

L-50-N

D.P.D.T. • on-on • Screw Terminals

15 A—125 V. A-C
10 A—250 V. A-C
¾ H.P.-120 Volts A-C
1½ H.P.-240 Volts A-C

2230

S.P.S.T. • on-off • Screw Terminals

3 A—125 V. [T]
6 A—125 V.
3 A—250 V.

1887-LP

S.P.S.T. • on-off • Solder Lugs

10 Amp. 250 V. A-C
15 Amp. 125 V. A-C [L]
¾ H.P.-120-240 V. A-C

L-42-E

S.P.D.T. • on-off-on • Solder Lugs

10 Amp. 250 V. A-C
15 Amp. 125 V. A-C [L]
¾ H.P.-120-240 V. A-C

L-40-A

S.P.S.T. • on-off • Screw Terminals

½ Amp. 125 V. D-C
3 Amp. 125 V. A-C
6 Amp. 24 V. D-C

K-10-A

S.P.S.T. • on-off • Screw Terminals

10 Amp. 24 V. D-C
3 Amp. 125 V. A-C

L-20-E

S.P.D.T. • on-off-on • Screw Terminals

CIRCLE F MFG., CO.
TRENTON 4, NEW JERSEY
53rd Year

(*Continued from page 24A*)

NEW PRODUCTS

Safety Ladder. An easy-to-lock line of ladders from 8 to 12 steps, that roll easily to any location for reaching high places safely has been developed by Tri-Metal Ladder Company, Berwyn, Pa. This line of safety-step ladders has a new, simple-to-operate locking feature that raises casters and lowers the front legs of the ladders, locking them securely to the floor to prevent tilting, swaying, and slipping. The lock is easily engaged at the front of the ladder by foot pressure and will withstand years of hard use because there are no springs to wear out. The metal steps assure a firm footing for personnel; a protective railing at the sides and top of the ladder provides even greater security. The step ladder is available in gray, yellow, green, or aluminum color to harmonize with individual color schemes. Write to the manufacturer for additional details.

Recorder. The compact operations or events recorder, model *MDjr* consists of a drum which rotates at speeds from 4 minutes to 24 hours per turn, as ordered. It is used to record graphically when a machine or device is operating or when an operator is producing. No ink is used. A stylus rests against the chart paper with its adherent layer of white opaque wax crystals, the pressure of the stylus exposes the strongly contrasting color of the paper beneath. The stylus produces a slight

spiral tracing on the chart. The lead screw is also subject to an axial motion from the magnet responding to the input signal to cause the vertical line (patent applied for). By this means, more than 400 linear inches of clear and accurate recording can be had on a waterproof, easily filed chart. When the 24-hour rotation model is used, any given instant of successive days is instantly comparable inasmuch as they line up vertically. The transparent cover prevents tampering, keeps out dust, and permits the worker to see his production record as it is being made by him. For further information, contact Gorrell and Gorrell, Haworth, N. J.

(*Continued on page 41A*)

(Continued from page 36A)

New Products

record as it is being made by him. For further information, contact Gorrell and Gorrell, Haworth, N. J.

Sinuated Heating Element Wire. This flat, sinuated heating element wire provides a more flexible, more efficient heat producing medium that is particularly adaptable to electric heating problems generally where thin-wall and pliant construction is desirable. The flat sinuated element has maximum radiation surface exposure, promoting faster, more efficient heat transfer and operation at higher temperatures. Thus, smaller elements can be applied in less space without sacrificing the desired temperature. The wire is preformed to specification in width, length, turns per inch, and type and gage of wire. It is available, wound on spools or supplied in cut lengths. The flat sinuated width can be made from ⅛ inch to 3 inches. The width of sinuation is governed by the wire gage and the ability to handle it after it has been sinuated. Catalog data can be obtained from Syntron Company, 440 Lexington Ave., Homer City, Pa.

Waterless Air Conditioner. A completely new waterless type air conditioner that eliminates the need for costly and bulky ductwork generally required for packaged installations has been announced. Designated as the *ACI-R* Air Conditioner the model is available in sizes ranging from 3 through 15 tons and is intended for commercial, industrial, and residential applications. Engineered to allow remote installation of an air cooled condenser, the compressor and evaporator package can be installed anywhere in the conditioned area, according to the company. The only connections necessary are refrigerant lines; thus, all duct work for the air cooled condenser is eliminated which not only reduces installation costs but increases efficiency. Installation of the new unit is simplified by a refrigerant shut-off valve on the gas side of the receiver. Field installation consists simply of running refrigerant lines from the compressor to the remote air cooled condenser and back to the receiver. For additional information contact American Coils Co., Farmingdale, N. J.

Oil Circuit Recloser. The first 200-megavolt amperes oil circuit recloser available to the electric power industry has been placed on the market by Line Material Industries. This new three-phase recloser, designated Type *W*, has been designed for application in substations, or on heavily loaded feeders where high fault currents may be expected. Accessories are offered that enable use of a Type *W* reclosed as a remote-controlled circuit interrupting device. For further information, write Line Material Industries, McGraw-Edison Company, Milwaukee 1, Wis.

(Continued on page 44A)

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25 years of

"packaged power"

At Weyerhaeuser Timber Company, switchgear control batteries in Everett, Wash., sulphite mill are C & D PlastiCal® —the batteries built for control . . . and to last 25 years.

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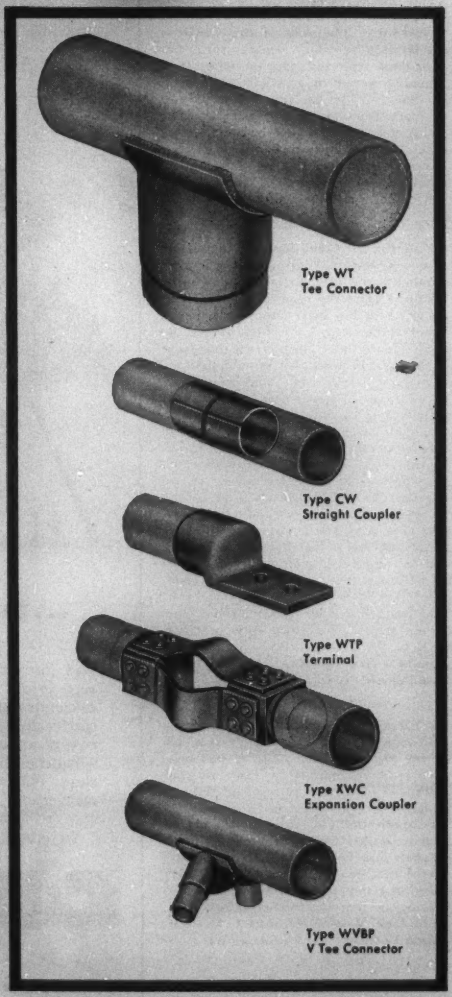
We also welcome inquiries on modifications or applications.



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cut cable installation costs the modern way...

with Loxarmor — the modern armored cable whose strength and flexibility make it a cost-saving alternative to conduit-enclosed cable. Rubber-insulated Loxarmor with its interlocking S-shaped armor is ideal for either power or control circuits.

Lower installation costs — Loxarmor eliminates conduit and related installation costs such as making bends and using pull boxes... especially economical to use in cramped quarters.

Easier to add or re-route circuits — Usually trained in trays or racks, Loxarmor cables are easily re-routed and are 100% salvageable. New cables are quickly added to existing trays.

Use indoors or outdoors — Loxarmor can be used in wet or dry locations. Indoors or outdoors, Loxarmor cables are readily accessible for easy inspection and maintenance.

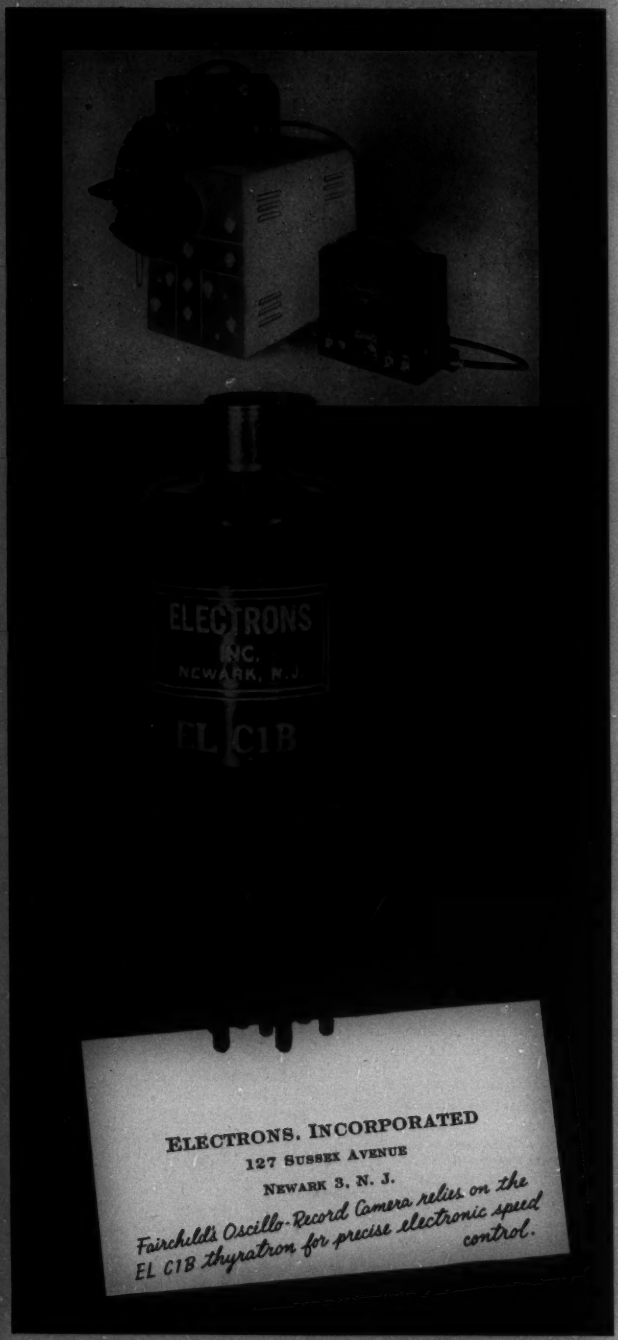
Less space required — Multiple Loxarmor circuits require only a little more than half the space needed for equivalent conduit circuits.

Loxarmor can be supplied over any standard Okonite insulation—rubber, varnished cambric or plastic—depending upon your installation conditions and voltage requirements. It is available with galvanized or stainless steel, aluminum or bronze armor. Either copper or aluminum conductors are of course available.

For dimensional data on Okonex rubber insulation applied by the strip-insulating process write for Bulletin EG-1090. Complete splicing and terminating drawings and instructions for Loxarmor are also included. The Okonite Company, Passaic, N. J.

where there's electrical power... there's **OKONITE CABLE**

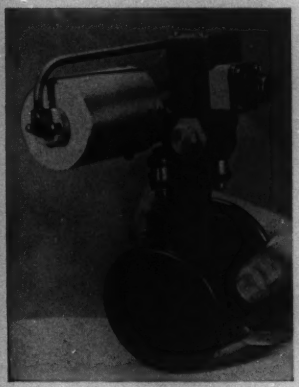
4740



(Continued from page 41A)

New Products

Electropneumatic Valve Actuator Assembly. A line of electropneumatic valve actuator assemblies that will operate at up to 300 pounds duct pressures has been developed by Vapor Heating Corporation. They are used to control the amount of hot air mixed with cold air flowing through air ducts for air conditioning the cabin in military jet planes and the new jet transports now being built. These new actuators and valves are considerably lighter and smaller than electric motor driven valves and lighter than many pneumatic valves now on the market. Actuating air pressure for the valve is drawn off the upstream side of the valve body, passing through an air passage next to the valve stem and feeds into the air



pressure regulator of the actuator. The variable air pressure in the duct is reduced down to a constant 15 pounds pressure needed to operate the valve. The air also passes through an air filter, made of sintered stainless steel, that will keep sand and dust out of the valve mechanism. There are two basic types of assemblies: the ON-OFF type, and the full-modulating variable opening type, which operates in conjunction with a magnetic amplifier control. These new Vapor electropneumatic valve actuator assemblies meet the latest military specifications. For further information please write to Vapor Heating Corporation, Department PR-57, 80 E. Jackson Blvd., Chicago 4, Ill.

Electronic Splicer. Two grades of Phenolite (registered trade mark) laminated plastic prove their superior electrical and physical properties in a new electronic film splicer. The unit, known as the Shepard Electronic Film Splicer, was developed by Shepard Laboratories, Inc., Summit, N. J., to solve the splicing problem of new nonacetate films such as Du Pont "Cronar." These Mylar type films

(Continued on page 68A)

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HEAVY-DUTY

ELECTRICAL CONNECTOR

Intended for use with jacketed cable and not requiring ground return through mating surfaces, this connector incorporates sealing gaskets at all mating joints.

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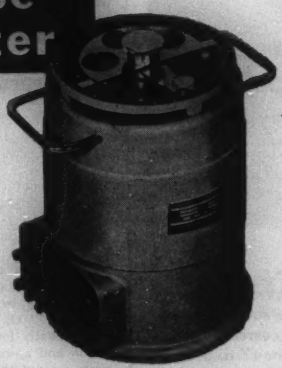
Type Q



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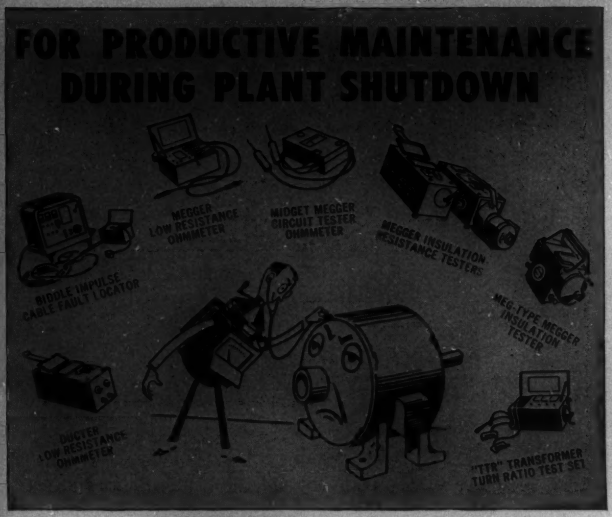
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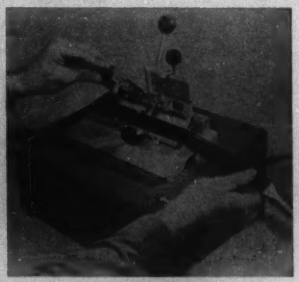
(*Continued from page 44A*)

New Products

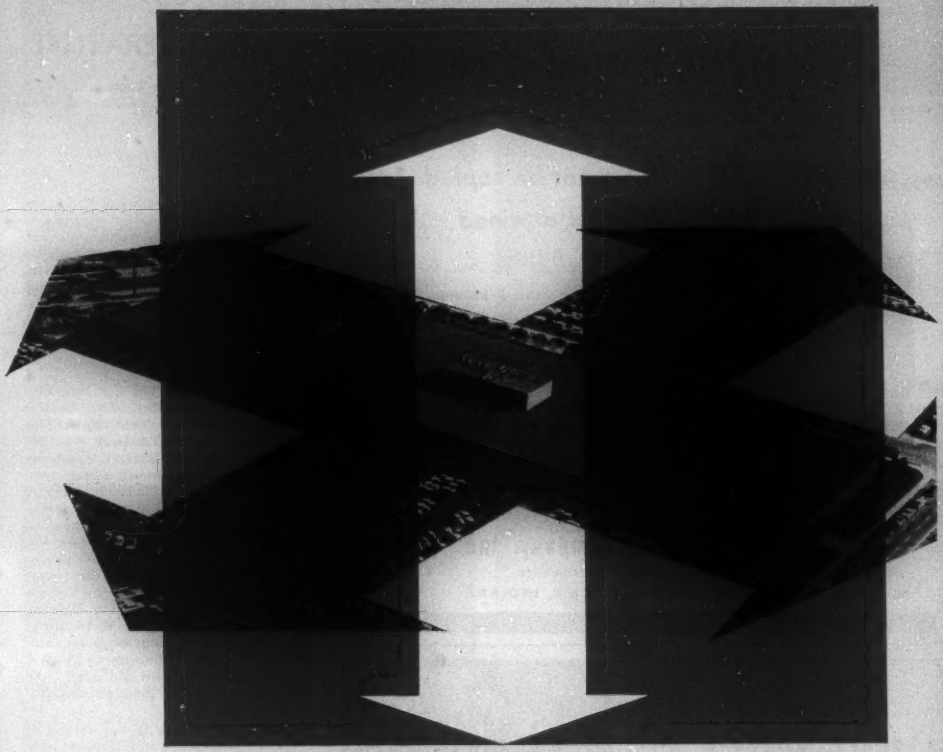
cannot be joined by regular film-splicing adhesives. The company uses dielectric heat to form a bond between the two film ends to be spliced. Intense high-frequency energy is applied to the overlapped ends of the splice, fusing them so quickly that the original molecular orientation of the film is not disturbed. This bonding



method retains the original high strength and durability of the film. Because of sharp energy reduction the instant the splice fuses, there is no danger of the film "burning." The electronic film splicer can also be used on standard acetate films.

Demineralization System. The problem of ultrapure water for cleansing transistors, tube parts, and other critical components, has been solved by a point-of-use demineralization system consisting of *T-20* mono-column demineralization units and a *SR-1* regenerator. Ultrapure water with a resistance of 10-megohms or better has become a necessity in close-tolerance industries, such as electronics, instruments, aviation, etc., where a mineral impurity as low as one-half part per million in rinse water can decrease product life by one half. Compounding the problem has been the fact that even when highly pure water is available from a plant's central demineralization unit, distribution through metal pipes and valves to points-of-use results in loss of the desired degree of ultrapurity. The new Penfield *T-20, SR-1* system solves this problem by purifying the water at the points of use. The *T-20* mono-column units used for this purpose eliminate all danger of metal contamination by having all their wetted parts of plastic construction. Operating costs remain exceptionally low because the mixed-bed cation and anion resins used in the *T-20* units are not thrown away after they are exhausted, but are regenerated quickly and easily by the company's *SR-1* regenerator, an in-plant component of the new demineralization system. Further information about the point-of-use demineralization system may be secured by writing E. H. Clohessy, General Manager, Penfield Manufacturing Co., Inc., 19 High School Ave., Meriden, Conn.

(*Continued on page 72A*)



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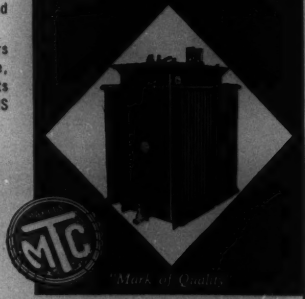

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(*Continued from page 68A*)

TRADE LITERATURE

Quick-Disconnect Strip Terminals. A complete line of production-installed "Fingrip" quick-disconnect strip terminals is described in a new 4-page bulletin available from Burndy Corp., Omaton Division, Norwalk, Conn. Male, female, and right-angle terminals are described for wiring applications in stoves, oil burners, switches, fans, timers, harnesses, and a variety of major and smaller electrical appliances. The bulletin contains complete test data including pull-out, pull-off, and heat tests, and dimensional and installation information. The "Termatic" automatic installation machine for production installation of Fingrips is also described. Write to the company for further information.

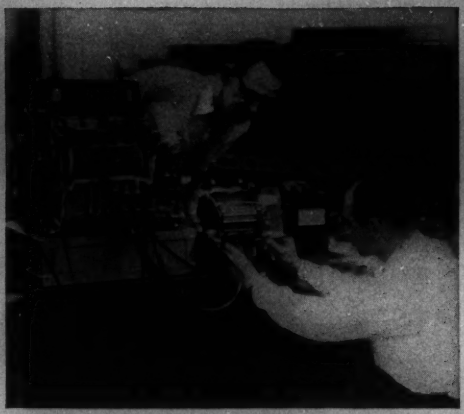
Technical Quarterly. The first issue of a new technical magazine, *The Western Electric Engineer*, has been published by the Western Electric Company, Inc., 195 Broadway, New York 7, N. Y. Appearing quarterly, the magazine will contain comprehensive articles on many branches of engineering at Western Electric, the manufacturing and supply unit of the Bell Telephone System. It will go to Western Electric's 6,300 engineers, and also will be available to technical and scientific people outside the company. Among the new magazine's departments is "The Engineer and Society," which contains short articles reflecting the increasing social responsibility of the engineer. Engineers, physicists, chemists, mathematicians and other technical people will contribute articles.

Instrument Catalog. A 16-page catalog of laboratory analytical instruments has been published by the Perkin-Elmer Corporation, Norwalk, Conn. The catalog describes the company's line of infrared and ultraviolet spectrophotometers, monochromators, flame photometers, vapor fractometers, as well as accessories and instrument components available for use with them. Also included is a brief description of the company's process control instruments.

Photoconductors. Infrared-sensitive lead sulfide photoconductors for detection and guidance systems are described in a new bulletin offered by Electronics Corporation of America, Cambridge, Mass. Technical specifications and ordering information is given for four general cell types having a wide range of performance characteristics. Charts for cell response as a function of both wave length and source temperature are shown. Lead sulfide semiconductive surfaces have advantages over other radiation-sensitive materials in terms of response, sensitivity, response time, and signal-to-noise ratio, according to the bulletin. Their applications include missile guidance, fire control, aerial mapping, data reduction, and spectroscopy. Copies of the new bulletin may be obtained by writing to Electronics Corporation of America, Photoconductor-Trans-

(*Continued on page 82A*)

MECHANICAL ENGINEERS are using their skills in the design and development of new mechanisms required for business machines and for those mechanical products which are associated with electronic data processing equipment.



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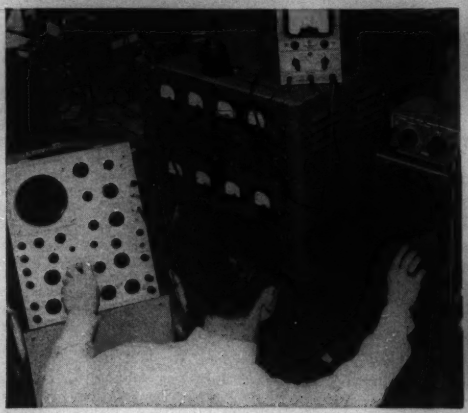

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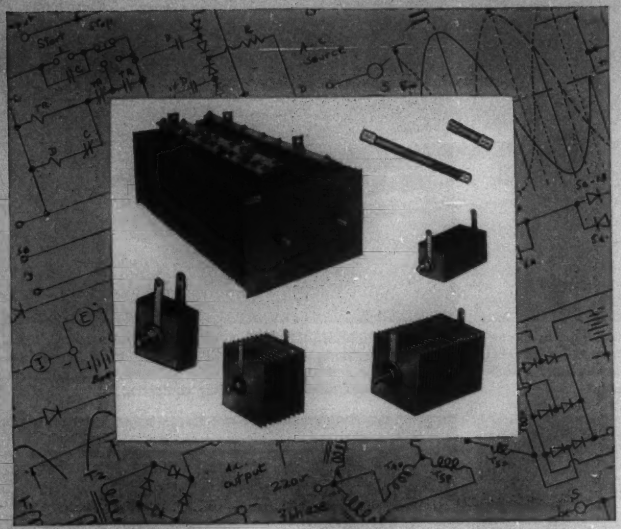

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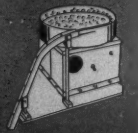

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(Continued from page 72A)

Trade Literature

Specifications for Aluminum Alloy. Military specifications for alloy *6066*, developed by Harvey Aluminum, Torrance, Calif., are available for general distribution. The specification *MIL-A-25493*, United States Air Force USAF), effective 1956, covers aluminum alloy bars, rods, and shapes produced by extruding. Copies of these specifications can be obtained by writing to the Commander, Air Material Command, Wright-Patterson Air Force Base, Ohio, Attention: *MCSIFF-2*, or the local military office issuing specifications. Alloy *6066* is recommended for applications requiring high strength combined with excellent corrosion resistance. The Harvey alloy, with a strength level equivalent to *2024*, has welding characteristics similar to *6061*.

Platinum Metals Review. In order to provide engineers, chemists, metallurgists, and other users with a source of current information on the properties and industrial applications of platinum and its associated metals, a new quarterly journal, "Platinum Metals Review," has been produced. This is being published by Johnson, Matthey & Co., Ltd., Hatton Garden, London, E.C. 1, England, the sole refiners and distributors of platinum metals from the Rustenburg Platinum Mines in South Africa. The first number of this journal contains articles on the protection of chemical process equipment, electrodeposited rhodium in coaxial radio frequency circuits, a thermocouple for high temperatures, the platinum metals in catalysis, and creep properties of platinum metals and alloys. It also provides a comprehensive service of abstracts of current literature on the platinum metals and their alloys. In addition, the first number contains an article describing operations at Rustenburg Platinum Mines, the world's largest producer of platinum. Copies of the Platinum Metals Review are obtainable from Johnson, Matthey & Co., Inc., 608 Fifth Ave., New York, N.Y., or from J. Bishop & Company, Platinum Works, Malvern, Pa.

Turbine Literature. Advances in the field of large steam turbines is the subject of new literature based on a paper by C. D. Wilson, chief turbine design engineer of Allis-Chalmers steam turbine department. The 12-page booklet covers a number of significant developments of interest to the power field. Copies of "Advances in the Field of Large Steam Turbines," no. 03R8620, are available on request from Allis-Chalmers Manufacturing Company, Milwaukee 1, Wis.

Hypot Pamphlet. A 4-page pamphlet and data sheets on the 5265, 5275, and 5280 mobile type direct-current Hypots have been published by Associated Research Incorporated. 3758 West Belmont Ave., Chicago 18, Ill.

(Continued on page 88A)

AIEE SPECIAL PUBLICATIONS

To meet a specialized need, or where it has become advantageous to collate a number of papers on a subject in one pamphlet, a series of special publications has been established. Prices quoted are (M) for AIEE members, and (N) for non-members.

		PRICE M	N
S4	Advanced Methods of Mathematical Analysis as Applied to Electrical Engineering (1942)	.50	.50
S74	AIEE Electric Heating Conference (4/55)	2.50	2.50
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S97	Bibliography on Gaseous Dielectric Phenomena (4/57)	.75	.75
S62	Bibliography on High-Pressure Electric Arcs (5/54)	1.50	1.50
S39	Bibliography on Industrial Control (9/50)	1.25	2.50
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S87	Bibliography on Testing of Insulating Materials and Systems for Thermal Degradation (4/56)	.50	.50
S60	CIGRE Report on Corona Losses (7/52)	.75	.75
T86	Conference on Magnetic Amplifiers	4.00	4.00
T91	Conference on Magnetism and Magnetic Materials (2/57)	7.50	7.50
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T72	Electrical Utilization of Aluminum Conference (3/55)	3.50	3.50
S23a	Electron Tube Survey of Instrument Manufacturers and Laboratories (3/48)	1.00	2.00
S50	Electronic Converter Applications and Tubes (7/52)	3.50	3.50
S25	Elements of Nucleonics for Engineers (3/49)	.60	1.20
S2	Grounding Principles and Practice (6/45)	.50	.50
S84	Index to United States Rectifier Patents (12/54)	1.00	1.00
S54	Joint AIEE/IRE Conference on Telemetering and Remote Control (4/53)	3.50	3.50
S37	Lightning Reference Bibliography (4/50)	.35	.70
S28	Mathematics for Engineers	.15	.30
S65	National Telemetering Conference—1954	2.00	2.00
S57d	1953 AIEE Aircraft Technical Conference, Part II, Discussions (3/54)	.50	.50
S45	Power Supply for Resistance Welding Machines (4/52)	1.00	1.00
S81	Principles of Transmission Line Relayings (12/55)	1.00	1.00
T70	Proceedings of the Eastern Joint Computer Conference (4/55)	3.00	3.00
T85	Proceedings of the Western Joint Computer Conference	3.00	3.00
S44	Review of Electronic Digital Computers (2/52)	3.50	3.50
S53	Review of Input and Output Equipment Used in Computing Systems (3/53)	4.00	4.00
S42	Sources of Electrical Energy (1/51)	.75	1.50
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S82	Symposium on Research and Education (2/56)	.80	1.60
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T76	Western Joint Computer Conference (3/55)	3.00	3.00

*An AIEE Conference Report, consisting of the full texts of the papers and discussions presented at a special AIEE technical conference on the subject.

Also available is the following publication, issued by EJC (Engineers Joint Council) of which AIEE is a member:

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(Continued from page 82A)

Trade Literature

Magnetic Controls Pamphlet. A pamphlet on magnetic controls has been published by Magnetic Controls Corporation, 6405 Cambridge St., Minneapolis 16, Minn. A comparison chart of the magnetic system and its desirable features versus the vacuum tube system is included.

Microfilm Brochure. The widening scope of microfilm as an everyday office, engineering department, and record room work tool for active paper work is detailed in a 4-color, 36-page brochure just issued by the Filmsort Division, Dexter Folder Co., 50 South Pearl St., Pearl River, N.Y. Titled "New Horizons with Microfilm," the booklet describes the conception and growth of the Filmsort system for activating microfilm by mounting it in aperture cards or jackets; gives details of new equipment, supplies and techniques for handling engineering drawings, personnel, and other office records, traffic control material, etc.; and provides several pages of case history reports on applications, savings, and other benefits. The concept for the Filmsort system originated during World War II when the OSS started employing unitized microfilm techniques to simplify the filing, finding, and reproduction of millions of maps, foreign postcard scenes, and other data. Since then techniques and equipment have been developed by Filmsort to permit advantageous use of unitized microfilm (individual frames or panels of from 2 to 30 or more 16-mm or 35-mm pieces of microfilm) in a wide variety of office, engineering department, and other record control systems involving anything from a few high rate of reference documents to tens of thousands or millions.

Laminate Booklet. "New Formica Cirprint" is the title of a four-page, two-color brochure now available, describing the characteristics of Cirprint, the new copper-clad laminate specifically developed for the printed circuits used in the radio and television industries. Cirprint exceeds National Electrical Manufacturers Association standards for *XXP* and additionally meets military specification *MIL-P-3115B* for type *PBE-P*. Copies of the brochure, number 755, can be obtained by writing Formica Corporation, 4411 Spring Grove Ave., Cincinnati 32, Ohio.

Catalog and Company Expansion. The newest line of electronic components manufactured by the Freed Transformer Co., Inc., is featured in a 48-page catalog. Transformers, filters and discriminators, toroids, magnetic amplifiers and ultrasonic components are pictured and described in detail. Complete data on transformers for military and commercial applications are also included. For catalog no. 571 write Freed Transformer Co., Inc., 1718 Weirfield St., Brooklyn 27, N. Y. The company also has expanded its facilities for encapsulating with Fosterite. The new production facilities will now permit the company to accept orders for Fosteriting from industry. For information write to the aforementioned address.